May 30, 1960

Aviation Week and Space Technology

Swiss Offer P.16 Strike Fighter In World Market

First German Lockheed F-104s

SIX EIA TYPES

PSI microdiode™

SUPER-MINIATURIZED SILICON DIODES

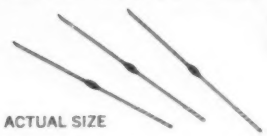
NEW SPECIFICATIONS

on the world's

SMALLEST DIODES

IN897 · IN898 · IN899 · IN900 · IN901 · IN902

VERY LOW LEAKAGE • 250 mW DISSIPATION • RELIABILITY ≥ CONVENTIONAL DIODES

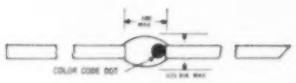


ACTUAL SIZE

ELECTRICAL SPECIFICATIONS

Type No.	Min. Sat. Voltage @ 100 μA (v)	Min. Fwd. Current @+1.0 V (mA)	Maximum Reverse Current (μA)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res. (Ohms)	Max. Recov. Time (μS)
1N897	50	5	.025 (10V) .1 (40V)	5 (10V) 20 (40V)	100K	1.0
1N898	50	100	.025 (10V) .5 (40V)	5 (10V) 20 (40V)	100K	0.3
1N899	100	5	.025 (10V) .1 (80V)	5 (10V) 20 (80V)	100K	0.3
1N900	100	50	.025 (10V) .1 (80V)	5 (10V) 20 (80V)	100K	0.3
1N901	100	100	.025 (10V) .5 (80V)	5 (10V) 20 (80V)	100K	0.3
1N902	200	10	.025 (10V) 1.0 (100V)	5 (10V) 15 (100V)	200K	0.3

Phone, wire or write for new low prices and delivery schedules on production quantities.



ENLARGED VIEW

Announcement of these new low leakage Micro-Diode types coincides with a general price reduction of up to 20% on the current PD-100 Micro-Diode series.

Excellent delivery is being made on both the original PD-100 series and this new EIA series of Micro-Diodes. A large number of manufacturers are already designing Micro-Diodes into highly advanced microminiaturized systems.

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LOS ANGELES—8271 Melrose Ave. OLive 3-7850

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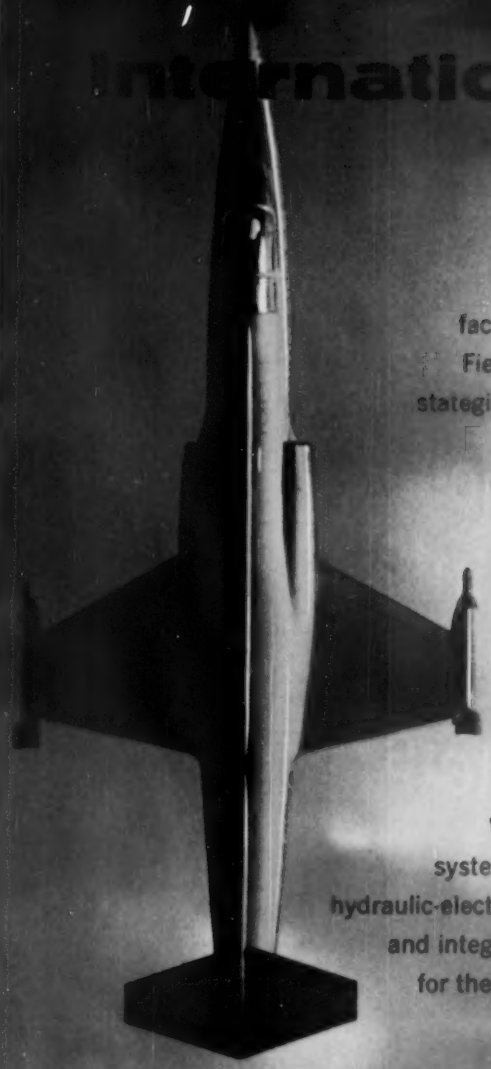
OFFERS INTERNATIONAL SERVICE TO AN

International Fighter



VICKERS INCORPORATED has sales and service facilities for a complete line of fluid power equipment. Field Service Representatives and overhaul depots are strategically located overseas. Further support is provided through technical training of military and prime contractor service personnel.

High performance aircraft, such as the F-104 Series Starfighter are the result of close teamwork between aircraft manufacturers and their suppliers. Vickers' reliable and efficient products and engineering know-how have made substantial contributions to these team efforts for over twenty years.

Vickers provides main system pumps, emergency hydraulic-electrical power packages, and integrated valve manifolds for the F-104 series aircraft.

For more information send for Bulletin A-5233C.

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PIONEERS IN TURBINE POWERED HELICOPTERS

AVIATION CALENDAR

June 9-10—Columbium Metallurgy Symposium, sponsored by Hudson-Mohawk Section of American Institute of Mining, Metallurgical and Petroleum Engineers and The Metallurgical Society of the Institute, Sagamore Hotel, Bolton Landing, Lake George, N. Y.

June 14-16—35th Meeting, Aviation Distributors and Manufacturers Assn., Queen Elizabeth Hotel, Montreal, Canada.

June 15—First Annual Flight Safety Seminar, Connecticut Dept. of Aeronautics, Air Guard Auditorium, Bradley Field, Windsor Locks, Conn.

June 15-17—1960 Heat Transfer and Fluid Mechanics Institute, Stanford University, Stanford, Calif.

June 19-24—Summer General Meeting, American Institute of Electrical Engineers, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

June 22-24—1960 Conference on Standards and Electronic Measurements, NBS Boulder Laboratories, Boulder, Colo. Co-sponsors: Institute of Radio Engineers' Professional Group on Instrumentation; Radio Standards Laboratory, National Bureau of Standards; American Institute of Electrical Engineers' Instrumentation Division.

June 23-25—16th Annual Meeting, Institute of Navigation, U. S. Air Force Academy, Colorado Springs, Colo.

June 26-July 1—63rd Annual Meeting and Apparatus Exhibit, American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 27-29—Fourth National Convention on Military Electronics, Institute of Radio Engineers, Sheraton-Park Hotel, Washington, D. C.

June 28-July 1—National Summer Meeting, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif.

July 3-4—Fourth Annual Fort Wayne Na-

(Continued on page 6)

AVIATION WEEK and Space Technology

May 30, 1960

Vol. 72, No. 22

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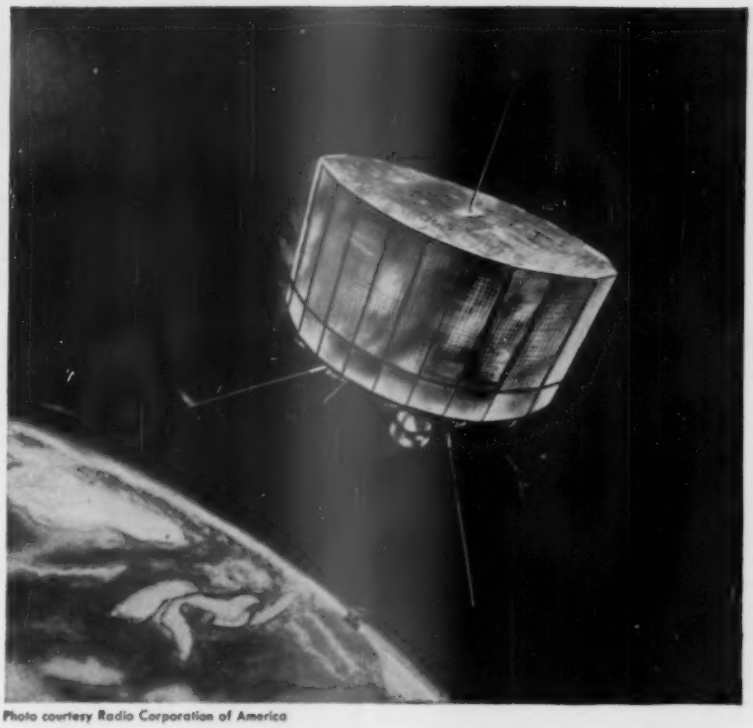

Photo courtesy Radio Corporation of America

aerospace

Components for RVX and TIROS Projects by LAVELLE

Major successes in the nation's accelerated space vehicle and missile programs include precision sheet metal components made by Lavelle. Among these is the fabrication by Lavelle of the structure of the new U. S. earth-circling TIROS weather observation satellite produced for the National Aeronautics and Space Administration by the Astro-Electronics Products Division, RCA. An artist's view of TIROS in orbit is shown above.

Photo courtesy World Wide Photos, Inc.

Pictured also is the recovery of the first successful RVX series re-entry vehicle after ICBM range flight. The aluminum alloy nose cone structure for this test was fabricated by Lavelle under sub-contract from the General Electric Company's Missile and Space Vehicle Department.

Some of the reasons why Lavelle has been selected to be a part of such dramatic projects are illustrated in a new brochure. Write for your copy.

Lavelle

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PHOTOSCAN, a radical advance in aerial reconnaissance technique, makes it possible to transmit visual information from manned or unmanned aircraft to ground receivers in seconds, without loss of detail.

The high performance of CBS LABORATORIES PHOTOSCAN is illustrated above. On the left is an enlarged portion of the original aerial photo which covered an area of sixty-four square miles. On the right is a portion of the reconstituted picture after transmission through the PHOTOSCAN System.

Challenging career opportunities are available at CBS LABORATORIES on long-range systems development programs such as PHOTOSCAN. Positions for physicists and electrical engineers are now open in the following department: Military and Industrial Systems; Acoustics and Magnetics; Solid State Physics; and Vacuum Tube Physics.

Please forward resumes in complete confidence, or obtain additional information by contacting CBS LABORATORIES.

CBS LABORATORIES

HIGH RIDGE RD. STAMFORD, CONN. • A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

AVIATION CALENDAR

(*Continued from page 5*)

tional Championships (civilian, closed-course airplane races), Fort Wayne, Ind.

July 5-15—Special Summer Program in Inertial Guidance—Terrestrial and Interplanetary, Massachusetts Institute of Technology, Cambridge, Mass.

July 11-12—Conference on Response of Metals to High Velocity Deformation, Stanley Hotel, Estes Park, Colo. Sponsor: Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

July 18-19—Liquid Rockets and Propellants Conference, American Rocket Society, Ohio Union Building, Ohio State University, Columbus, Ohio.

July 28-29—Seventh Annual Symposium on Computers and Data Processing, Denver Research Institute, University of Denver, Stanley Hotel, Estes Park, Colo.

Aug. 1-3—Fourth Global Communications Symposium, Statler Hilton Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers; U. S. Army Signal Corps.

Aug. 1-3—"Future of Manned Military Aircraft" (Classified Meeting), Institute of the Aeronautical Sciences, El Cortez Hotel, San Diego, Calif.

Aug. 2-11—27th Annual U. S. National Soaring Championships, Ector County Airport, Odessa, Tex.

Aug. 8-11—Western National Meeting, American Astronautical Society, Olympic Hotel, Seattle, Wash.

Aug. 8-12—1960 Pacific General Meeting, American Institute of Electrical Engineers, El Cortez Hotel, San Diego, Calif.

Aug. 15-20—11th Annual Congress, International Astronautical Federation, Royal Institute of Technology, Stockholm.

Aug. 18-19—Electronic Packaging Symposium, University of Colorado, Boulder, Colo.

Aug. 23-25—1960 Cryogenic Engineering Conference, University of Colorado, Boulder, Colo.

Aug. 23-26—Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Aug. 28-Sept. 5—1960 National Air Rally, Municipal Airport, Orange, Mass. Sponsor: National Aeronautic Assn.

Sept. 4-5—Civilian, Closed-Course Airplane Races, Lakefront Airport, Cleveland, Ohio.

Sept. 5-11—1960 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 12-16—16th Annual General Meeting, IATA, Copenhagen, Denmark.

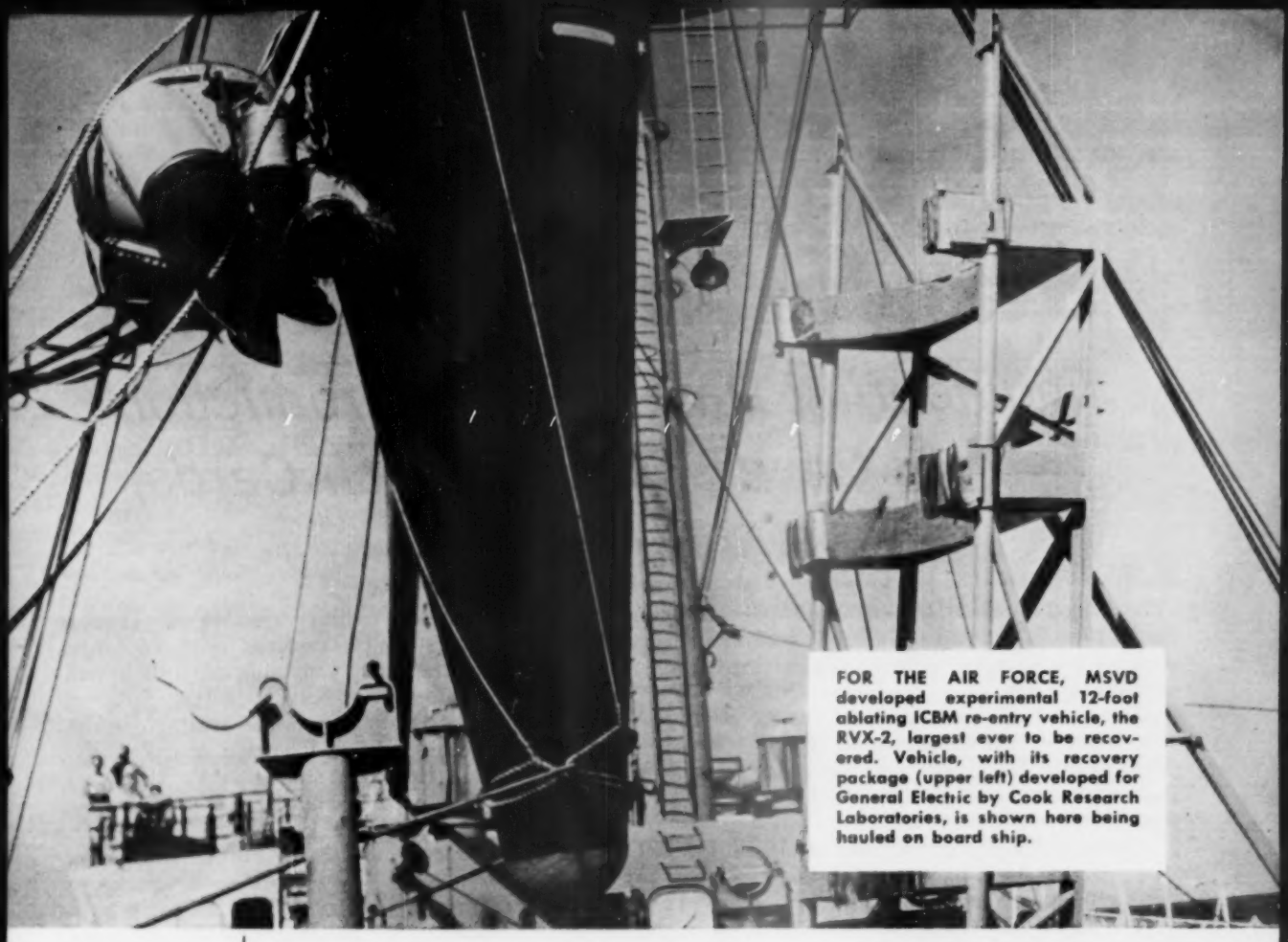
Sept. 12-16—Second International Congress, International Council of the Aeronautical Sciences, Zurich, Switzerland.

Sept. 14-16—Annual Meeting, National Assn. of State Aviation Officials, Wort Hotel, Jackson, Wyo.

Sept. 15-16—15th Annual Meeting, Armed Forces Chemical Assn., Sheraton-Park Hotel, Washington, D. C.

Sept. 19-22—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, Shoreham Hotel, Washington, D. C.

Sept. 21-25—National Convention and Aerospace Panorama, Air Force Assn., Civic Auditorium and Brooks Hall, San Francisco, Calif.



FOR THE AIR FORCE, MSVD developed experimental 12-foot ablating ICBM re-entry vehicle, the RVX-2, largest ever to be recovered. Vehicle, with its recovery package (upper left) developed for General Electric by Cook Research Laboratories, is shown here being hauled on board ship.

MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in search and recovery

With each recovery of a space vehicle, scientists gain important new knowledge about the environment of space and its potential effect on man and the operation of vehicles and equipment. As more advanced vehicles are developed for space flight—some with life aboard—successful location and recovery become increasingly vital.

General Electric's Missile and Space Vehicle Department pioneered in the development of space vehicle search and recovery techniques as part of its re-entry and recovery vehicle program for the U.S. Air Force. MSVD developed and built the first payload to be recovered from space—an 18-inch data capsule ejected from an Air Force Thor re-entry vehicle on June 13, 1958. Many such data capsules have since been recovered from both Thor and Atlas flights—some carried cameras providing films from space. MSVD also developed and built the 12-foot long, one-ton re-entry vehicle shown above which the Air Force recovered on July 21, 1959—the largest to be returned to date. Today, as MSVD builds and flight tests more complex vehicles, it is continually expanding and improving its already successful search and recovery program.

Currently, this search and recovery experience is being applied to the development of such important space programs as the Air Force "Discoverer" recovery satellites and NASA's radiation research recovery vehicles (NERV).

For more information about MSVD's work in search and recovery, write to Section 160–79, General Electric Co., Missile and Space Vehicle Department, Philadelphia 4, Penna.

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A Department of the Defense Electronics Division

***Scientists and Engineers interested in career opportunities in Space Technology,** contact Mr. T. H. Sebring, Dept. 160, MSVD*

Armed Forces Standardize Microfilm

Engineering Data Micro-reproduction System Covers Films, Punch Cards, Aperture Cards

The Armed Forces, operating active files containing more than 50 million drawings, have set military requirements for microfilming engineering drawings and related data.

The standards and specifications released April 15, 1960, by the Department of Defense for its Engineering Data Micro-reproduction System establish uniform methods for microfilming and standard formats for data presentation.

These uniform methods and standard formats, the Defense Department said, offer great space, time, and money savings.

New possibilities for inter-service exchange of engineering data are opened through the use of microfilmed drawings and related data, the Department of Defense announced.

What does this mean to industry?

Military agencies using the specifications of the Engineering Data Micro-reproduction System will ask contractors to submit engineering data in 35mm roll microfilm and punch cards. From the microfilm and punch cards, such military agencies make aperture cards to distribute engineering data for the procurement, maintenance, and supply of the nation's weapons systems.

In addition, other military agencies may require contractors to submit completed aperture cards. In these cases, the master microfilm and distribution copies are furnished in mounted aperture cards.

Even now, a number of prime contractors and sub-contractors are using a portion of the newly-adopted specifications and standards. For them, the new requirements will be integrated into existing programs.

Many contractors, anticipating the standards and specifications, have held microfilm programs in abeyance. Their engineering departments now have a ready-made set of instructions for upcoming programs.

The new standards and specifications are expected to have a cumulative effect. As more companies have microfilm equipment, industry will intensify its use of microfilm for distributing data. Even before specifications were announced, prime and sub-contractors were exchanging engineering data in microfilm format.

Industry helped set standards

Compatibility with industry is the keystone in the new standards and specifications of the Department of Defense. Industry originates much of the engineering data used by the DOD. Industry, in helping to set requirements, has created instructions that can be used for its own operations.

Standards cover broad areas

The standards and specifications documents already released are:

MIL-M-9868, Microfilming of Engineering Documents, 35mm Requirements for;

MIL-P-9879, Photographing of Construction/ Architectural Drawings, Maps and Related Documents, 105mm, requirements for;

MIL-C-9877, Cards, Aperture;

MIL-C-9878 Cards, Tabulating and Aperture for Engineering Data Micro-reproduction System;

MIL-STD 804, Formats and Coding of Tabulating and Aperture Cards for Engineering Data Micro-reproduction System;

MS-21319, Gage, Aperture Cards No. 201-1.

Interim Federal Specifications cover silver halide, diazo-type, and heat developing microfilm.

The complete Department of Defense standards and specifications cover:

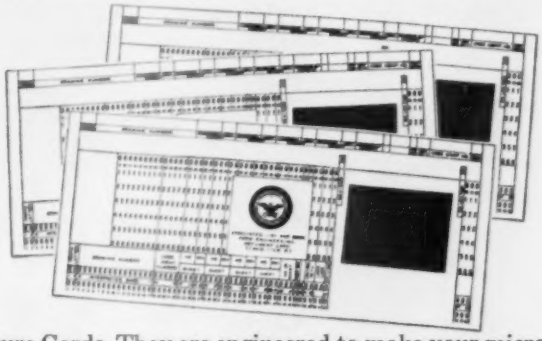
- The raw film stock used in microfilm;
- The methods and techniques of microfilming engineering data for the Armed Forces;
- The formats of the tabulating cards used to generate aperture cards;
- The formats of the aperture cards used as carriers for the microfilm data;
- The methods and techniques of mounting microfilm into aperture cards;
- The wide range of equipment to be used in the micro-reproduction system. This equipment includes microfilm cameras, testing equipment to inspect filmed engineering data, film mounters, film printers, and print-out units.

3M makes microfilm so easy to use

You can depend on 3M's continuing research, precision manufacturing, and standards-compatible products to make microfilm so easy to use.

FILMSORT Aperture Cards and Copy Cards, long used by Government and industry, are designed to meet the specifications and standards for the Engineering Data Micro-reproduction System. And now, to speed your use of FILMSORT Aperture Cards, 3M supplies both the printed card and the aperture. You save in shipping costs. You get your cards faster.

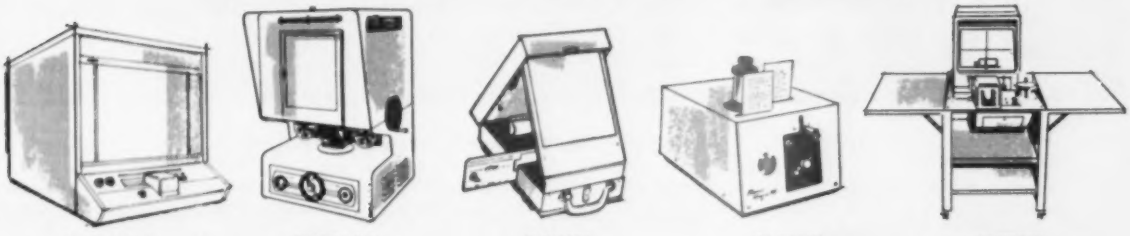
FILMSORT Microfilm Copiers, Mounters, and Readers are designed exclusively for Filmsort Aperture Cards. They are engineered to make your micro-reproduction system profitable.



THERMO-FAX "Filmac 200" Reader-Printers make microfilm practical for industry and Government. The advantages of a reader and a printer are combined in one compact, low cost unit. Huge viewing screen . . . simple push-button operation . . . you can obtain copy after copy in 18″ x 24″ size, or half size prints, of engineering drawings and records from microfilm in FILMSORT Aperture Cards. The "Filmac 100" Reader-Printer delivers 8½″ x 11″ copies in seconds.

For more information about the new Defense Department microfilm specifications and how they affect your business, mail the coupon right away.

Modern Microfilm Products from 3M



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THERMO-FAX "Filmac 100" Reader-Printer

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Please send detailed information on the new Department of Defense standards and specifications and about 3M Microfilm Products.

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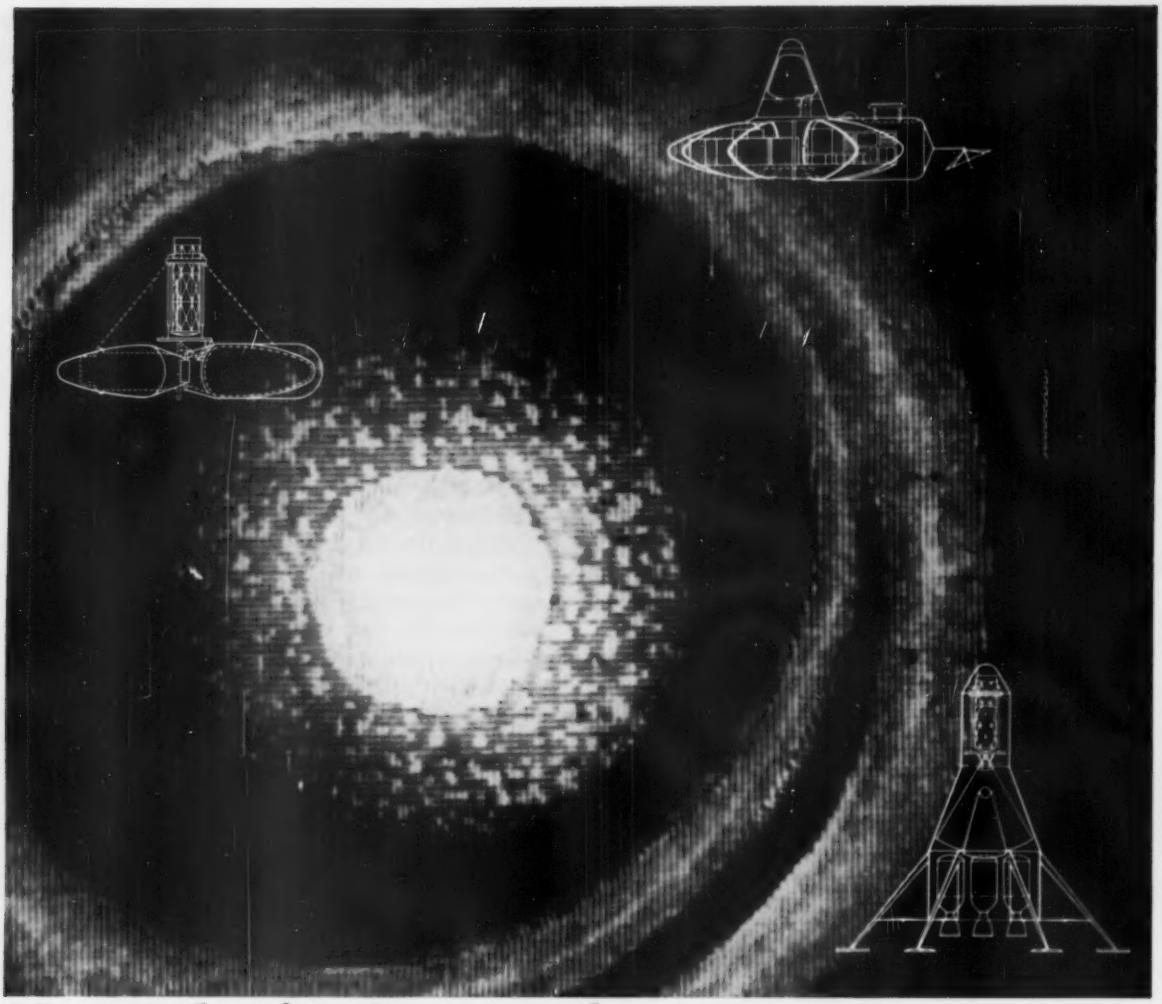

New styles for the man-about-space

Every time a space traveler leaves home (earth), he has to wrap himself in the complete environment necessary to his physiological and psychological well-being. Styling sealed space capsules to suit man's every requirement has been a major project at Douglas for more than ten years. Forty basic human factors areas were explored in these studies. Now Douglas engineers have evolved plans for practical space ships, space stations and moon stations in which men can live and work with security thousands of miles from their home planet. The company's wide experience in producing large rocket and pressurized aircraft systems has provided it with unmatched capabilities in the missile and space fields.

Dr. Eugene Konecci, Head, Life Sciences Section, reviews a new concept in space cabin design with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

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ENGINEERING TEAMWORK IN SPACE EXPLORATION

Engineers and scientists interested in a wide range of activities will appreciate the advanced nature of research and development projects under way at JPL. These projects include research, basic and applied, in Electronics, Solid State Physics, Propulsion, Aerodynamics, Structures and Materials and the design, development and analysis of space probes and satellites. Individually responsible engineers and scientists work together as a thoroughly integrated team in accomplishing the complete objective.

Programs involve guidance, telemetering, data recording and reduction, instrumentation, structures, propulsion, materials, solid state physics, components, heat transfer problems and systems analysis and are constantly influenced by continuing JPL space exploration research providing individuals with challenging assignments in almost every phase of engineering and science. Staff progress in diverse fields of activity is constantly being made.

Pioneering in basic research, applied research and development engineering in space exploration proves to be a stimulating attraction for engineers and scientists with innate curiosity and intense interest in the future of space exploration.

More men of this type are needed — if you believe you are qualified for the JPL team, send in your resume today.

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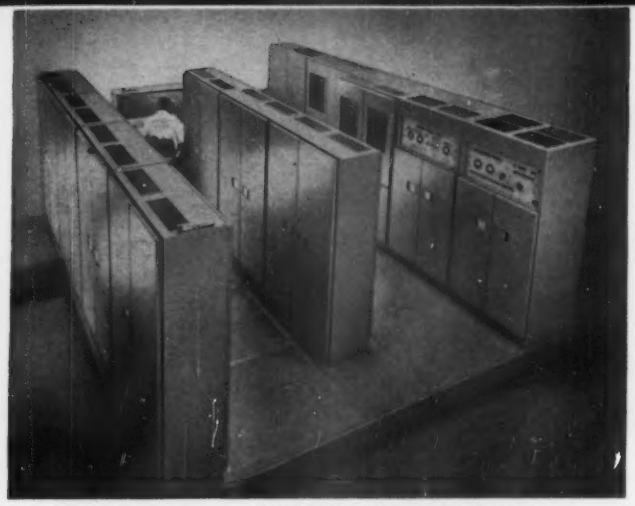
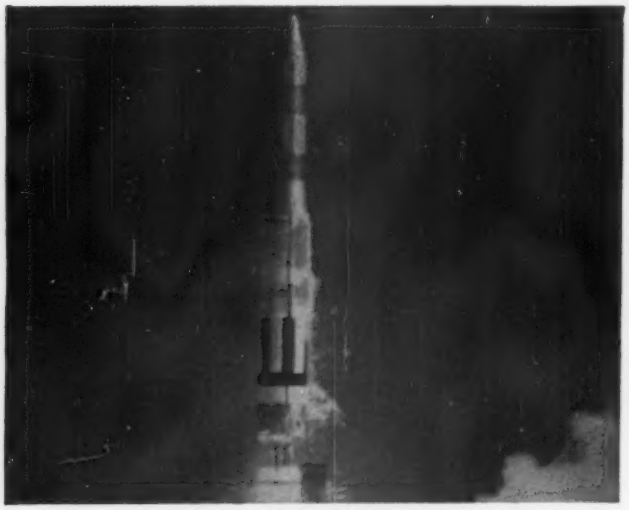


Building the Athena called for the development of new and rigorous quality control techniques to insure the reliability of its more than 100,000 components and 120,000 selectively soldered joints. All components were classified by Univac data processing equipment, which also kept permanent records of their performance.



Athena is the ground based guidance computer for the USAF Titan ICBM. The Athena continually computes the speed, elevation, direction, azimuth, and position of the Titan and compares this information with data stored in its magnetic memory. Responding to commands issued by the computer, the missile maintains a course which will put it on target.

From the **REMINGTON RAND UNIVAC**

Military Division

Ultra-Reliable Athena Computer Guides ICBM Titan to Target 5,000 Miles Away

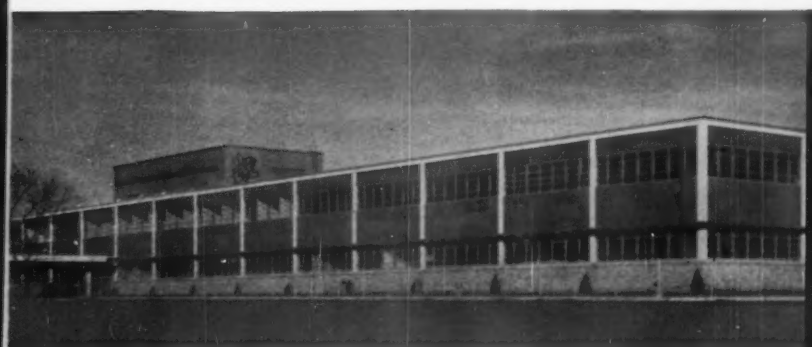
Recently an ICBM Titan missile was fired from Cape Canaveral by the USAF Ballistic Missile Division. The accuracy of the ground-based guidance system was such that technicians were able to quickly recover a data capsule within a target area 5,000 miles away.

This same system made possible the highly successful launching of TIROS I, America's television-equipped weather-eye satellite. The Athena computer, guiding a three-stage Thor-Able type missile, put TIROS I into the most nearly perfect circular orbit of any satellite, Russian or American, yet launched.

The Athena Digital Guidance computer was designed and produced by Remington Rand Univac to meet unprecedented reliability requirements. Several Athena computers have since been delivered and have logged thousands of operating hours. All have exceeded a reliability rating of 99.992 per cent, a record considered as a major breakthrough in the computer art.

The Athena is now a proud addition to the distinguished series of defense systems developed by the Military Division. In exceeding the contract specifications for reliability and delivering the computer ahead of schedule, the Athena program once more demonstrated the outstanding military capabilities of Remington Rand Univac.

UNIVAC®



Remington Rand

UNIVAC

DIVISION OF SPERRY RAND CORPORATION

Univac Park, St. Paul 16, Minnesota

Control and data systems developed by the Remington Rand Univac Military Division include:

ATHENA, the Ground Guidance Computer for the U.S. Air Force ICBM TITAN.

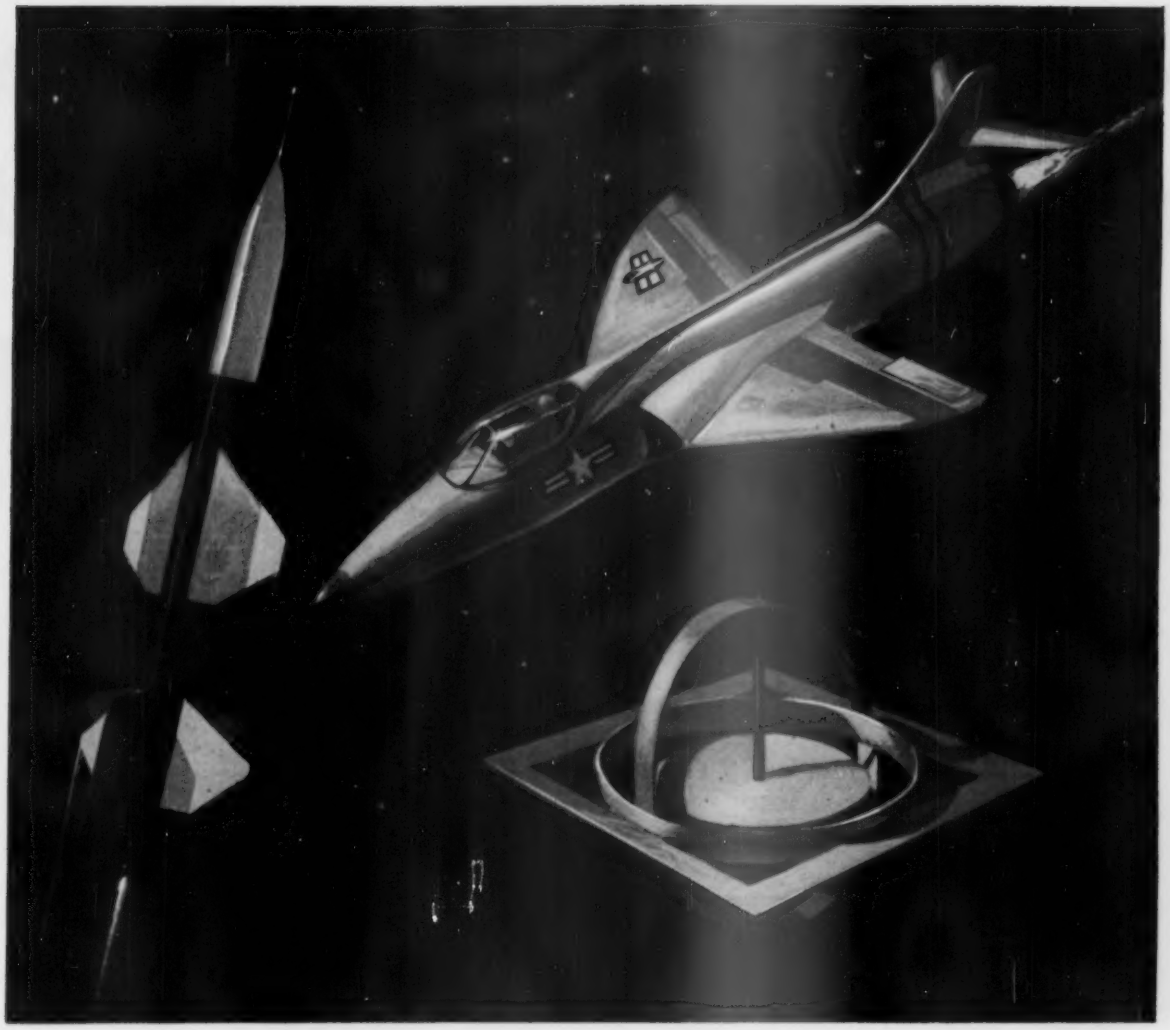
TACS AN/TSQ-13 (Tactical Air Control System for the U. S. Air Force)

BOMARC Computer for the U. S. Air Force Target Intercept Program

SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY

AN/USQ-20 (Advanced Computer for the U. S. Navy)

Additional information describing capabilities and experience or career opportunities may be obtained by writing to Remington Rand Univac at the above address.



20-pound inertial platform

By a precise balancing exercise, this silent, sleepless "pilot" will keep its craft on course as it streaks through space. The miniature, all-attitude inertial platform detects any pitch, roll or yaw deviations and is the heart of a precise navigation system.

The best news of all concerning this new inertial platform is Norden's success in achieving higher accuracy and reliability . . . in a significantly smaller package. The unit measures a mere 7¾ x 9⅜ inches and weighs less than 20 pounds. It offers optimum state of the art wherever stabilized spatial reference is required. This engineering accomplishment once again underscores Norden's capability in the fields of digital computing, gyro design and application, reliability techniques, and precision manufacturing. And it is a demonstration of the Norden philosophy at work . . . to extend man's capabilities.

• • •

Stimulating positions are available at all levels of responsibility for qualified engineers and scientists.

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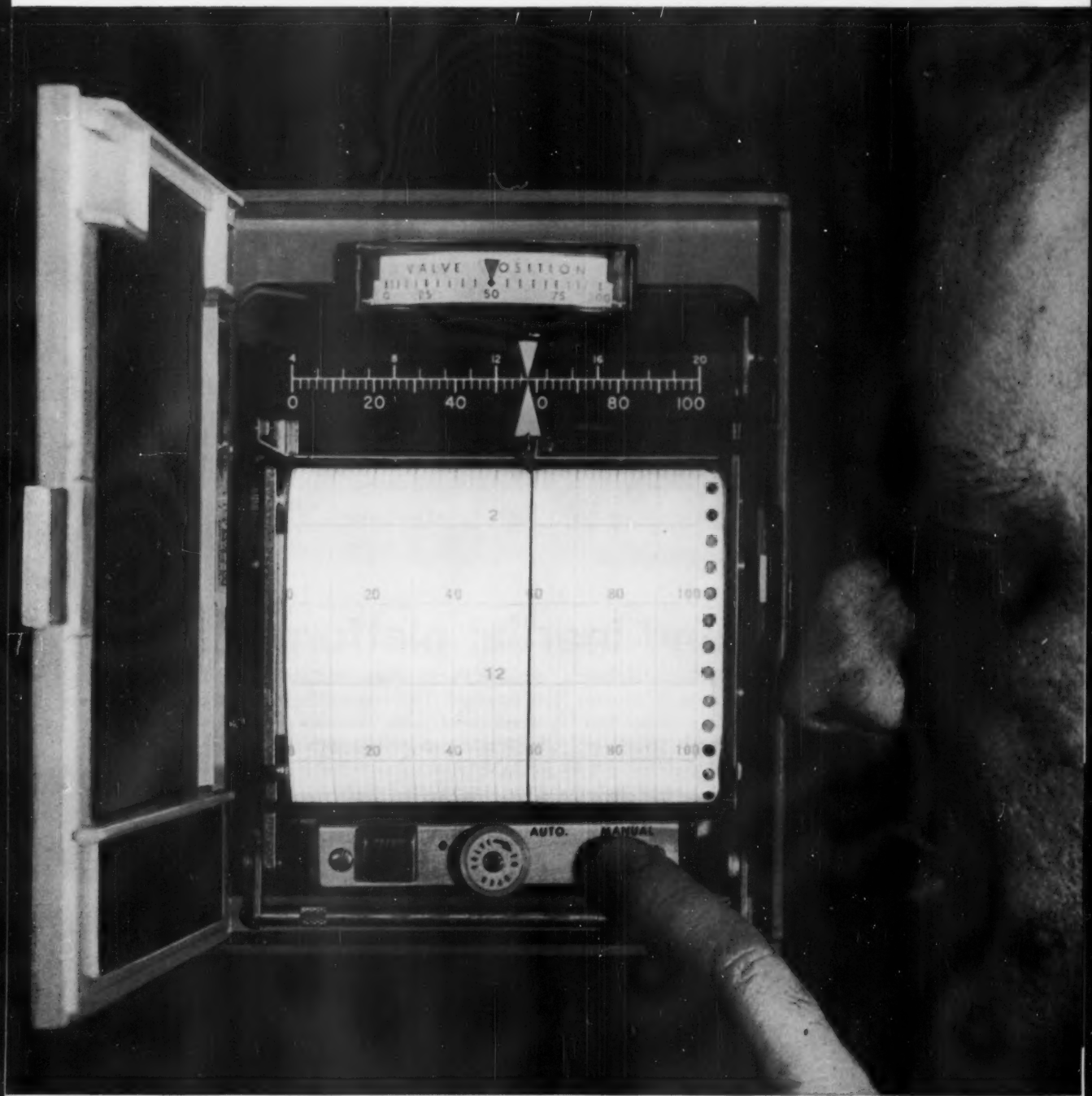
New *ElectriK Tel-O-Set*... needs in a single compact



everything an operator control station

This Honeywell electric control station meets all of your requirements for operator convenience.

One compact case houses *every* function the operator needs to supervise a control loop: indication of process variable and set point on the same scale; the controls needed to switch from automatic to manual; controls for manual control; and indication of valve position.

The *ElectriK Tel-O-Set* control station assures easier bumpless transfer than ever before available because there's no need to "line up" or "match" pointers. A null balance indicator eliminates guesswork, and the transfer doesn't have to be hurried since the valve remains under control during the transfer.

You can also order the controller with the proportional band, rate, and reset adjustments on the front of the panel conveniently located below the control station, or at the rear of the panel.

These are just a few of the features that make the new *ElectriK Tel-O-Set* control system an outstanding value. Your Honeywell engineer can give you complete details. Call him today . . . he's as near as your phone.

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Honeywell

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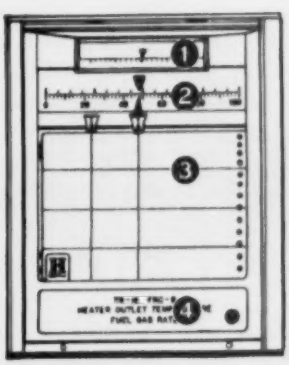

1. Valve position indicator continuously indicates controller output when on automatic control.

2. Set point index is conveniently located on same scale as process-variable pointer; you can see from a distance any deviation of variable from set point.

3. Rectilinear 4-inch calibrated chart is easy to read. At standard chart speed, four hours of recording is always visible. Unit has daily chart tear off or 30-day rewind. Both recorder and control station take the same 5½" x 6" panel cutout.

4. You get bumpless switching from automatic to manual control because you don't have to match pointers. In the balance position, the valve position indicator is part of a null circuit that compares controller output and manual output. When indicator reads 50%, both outputs are perfectly matched.

TRUE NORTH... anywhere–any time–any weather

A portable field instrument that finds true north automatically is now available to America's new mobile Army. It is called ABLE and has been TYPE CLASSIFIED by the U. S. Army, TO & E No. LIN279415. ABLE swiftly determines true north . . . day or night, in all weather, and anywhere in the world up to latitudes of 70 degrees.

The simplicity, speed, and precision of ABLE compared with surveying methods means a saving in time, manpower, and equipment . . . and is in keeping with the modern Army's concept of battlefield mobility.

Heart of the 100-pound all-transistorized system is a high-precision gyro which senses true north. Its accuracy is equal to most celestial methods under tactical conditions. ABLE components have a mean-time-to-failure in excess of 3000 hours. ABLE can also provide directional orientation for field-operated mobile radar and missile launchers.

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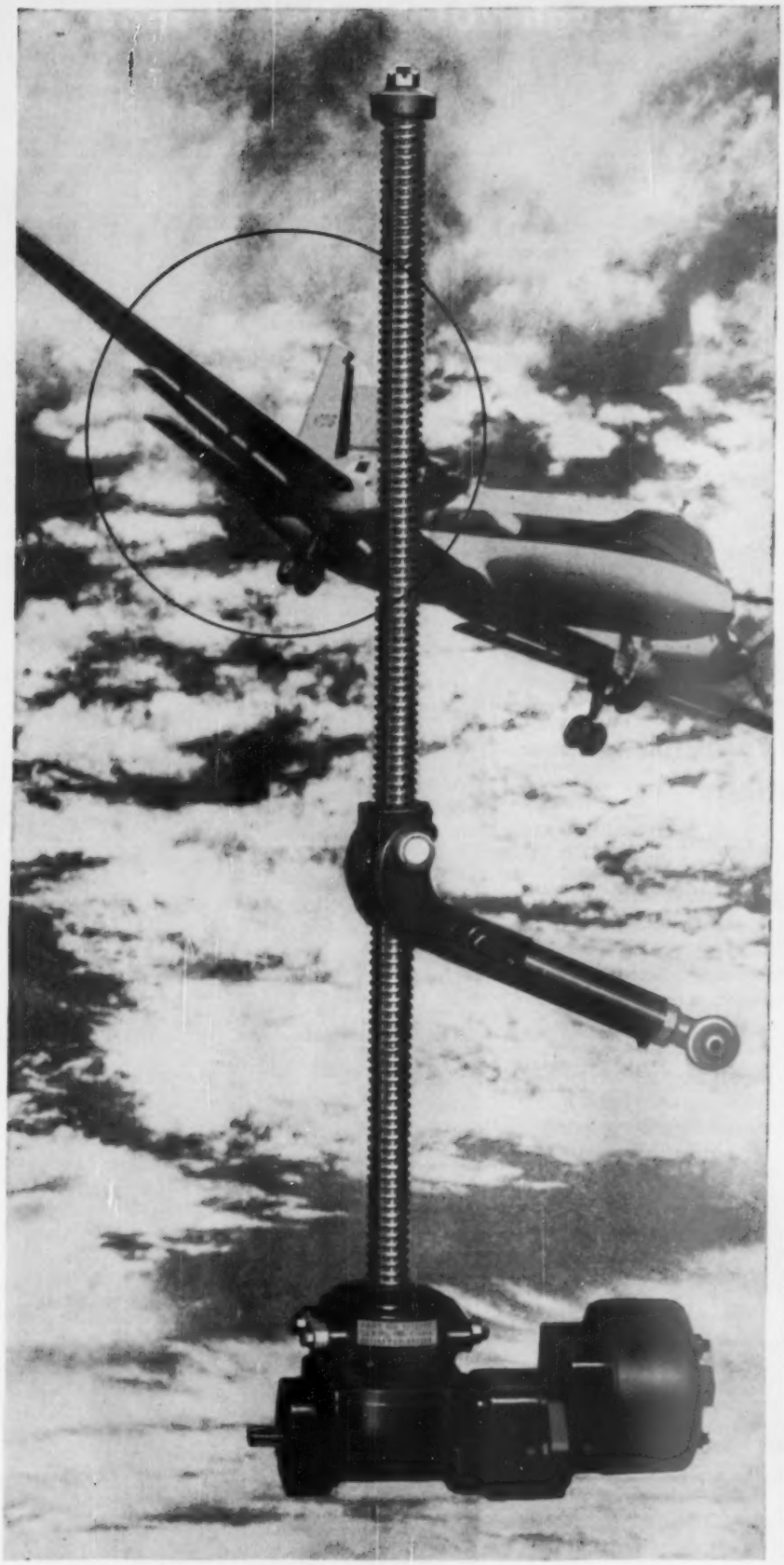

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newest business aircraft equipped with Kelsey-Hayes wing-flap actuators

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Capable of operating from short runway airports, Gulfstream gets its wing flap action from a hydro-mechanical actuation system designed and produced by our SPECO Division in Springfield, Ohio.

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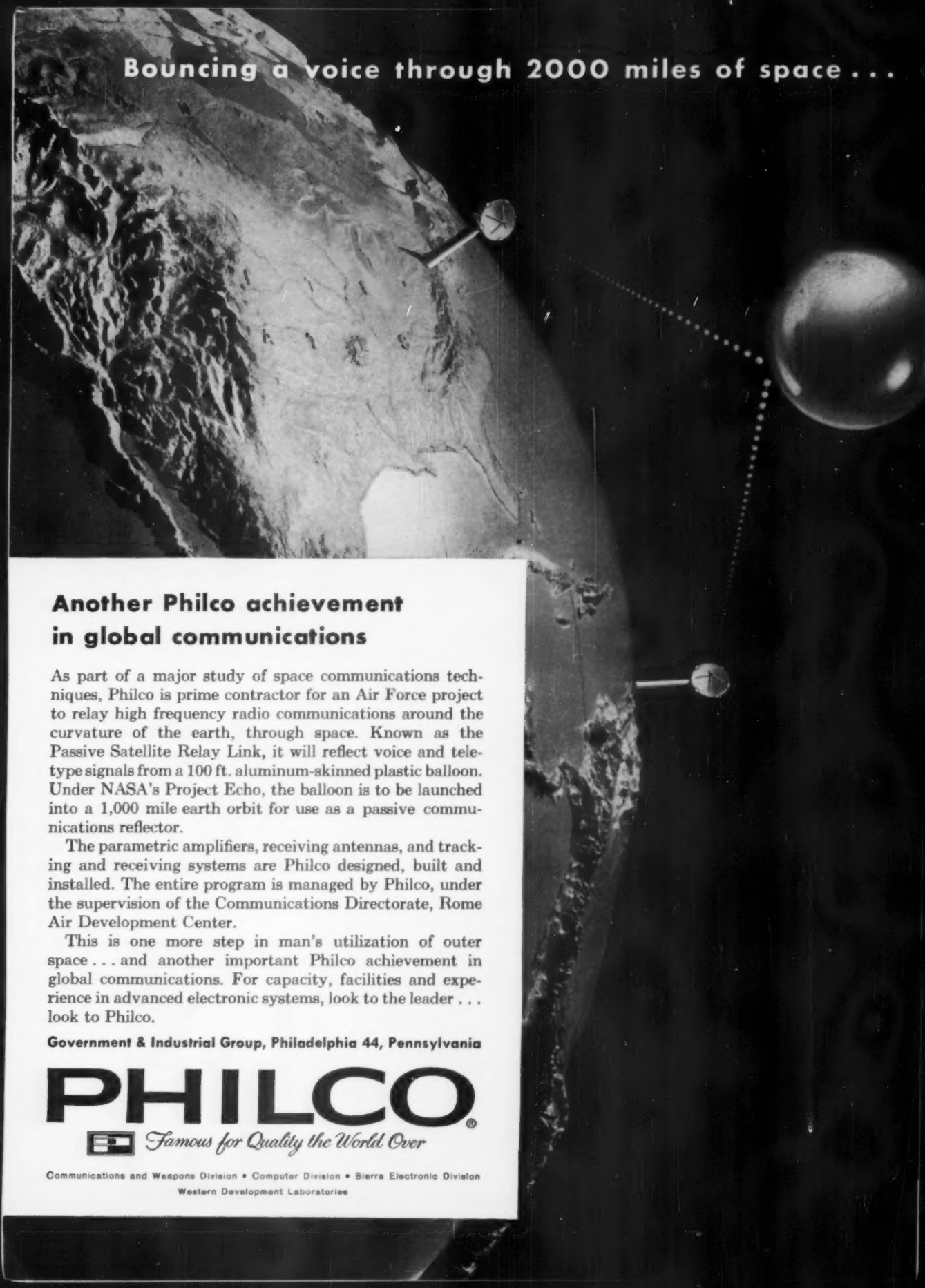

Another Philco achievement in global communications

As part of a major study of space communications techniques, Philco is prime contractor for an Air Force project to relay high frequency radio communications around the curvature of the earth, through space. Known as the Passive Satellite Relay Link, it will reflect voice and teletype signals from a 100 ft. aluminum-skinned plastic balloon. Under NASA's Project Echo, the balloon is to be launched into a 1,000 mile earth orbit for use as a passive communications reflector.

The parametric amplifiers, receiving antennas, and tracking and receiving systems are Philco designed, built and installed. The entire program is managed by Philco, under the supervision of the Communications Directorate, Rome Air Development Center.

This is one more step in man's utilization of outer space . . . and another important Philco achievement in global communications. For capacity, facilities and experience in advanced electronic systems, look to the leader . . . look to Philco.

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Titan, Atlas May Boost Rover Rocket 26
▶ Use of Saturn for flight-tests of nuclear rocket also may be proposed under NASA study contracts.

CAB Suspends Proposed Rate Increases 38
▶ Board action halts filing of widely-varied fares; order implies levels suggested so far are too high.

USAF's Satellite Test Center Grows 57
▶ Air Force, Lockheed Aircraft team for Discoverer series test program, on-the-job Satellite Test Wing training.

SPACE TECHNOLOGY

USAF's Satellite Test Center Grows... 57
Titan, Atlas May Boost Rover Rocket 26
NASA Centralizes Launch Management 28
Relay Repeater Satellite..... 35
Soviet Sputnik IV Re-Entry Fails..... 35
Midas Tests Detection System..... 36
Saturn System Design Details..... 64

MISSILE ENGINEERING

Bulova Igniter for Minuteman..... 92
Atlas 56-D Long Range Shot..... 37
Polaris Sub Simulator..... 93
Soviets Parade Missiles..... 94

AERONAUTICAL ENGINEERING

Swiss Seek World P.16 Sales..... 66
U-2 Carried Inertial Guidance..... 32
Congress Probes Summit Issues 33
UN Debates U-2..... 34
Aerial Reconnaissance Exercise..... 36
Second Project Rover Reactor..... 89

AVIONICS

BMEWS Nears Operational Status.... 76
Haloid Xerox RC Circuit Modules.... 85
Flight Patterns Displayed in 3-D..... 85
Filter Center 88
New Avionic Products 88

BUSINESS FLYING

SIAT 222 Prototype..... 90
F-27, 240 Executive Interiors..... 91

AIR TRANSPORT

CAB Suspends Proposed Rates..... 38
New York-Washington Service..... 39
707 Landing Gear Failure..... 41
Capitol Executive Shifts Continue.... 41
Examiners Debate CAB Reorganization 43
CAB Merger Decisions..... 45
Airlines Report Officers' Salaries..... 46
Atlantic Route Mergers Foreseen.... 47
Shortlines 49
Airline Observer 49
Airline Traffic—March, 1960..... 50

MANAGEMENT

GAO Objections to Management Plan 30
NASA Budget Boosted $55 Million... 31
Hurley Resigns From Curtiss-Wright.. 34
Who's Where 23
Industry Observer 23
Washington Roundup 25
News Digest 37

EQUIPMENT

Precision Altimeter Evaluated..... 95
What's New 96

Calendar 5
Letters 104

EDITORIAL

Top Priority for Military Space Systems. 21

COVER: Three of four Lockheed F-104F two-seat jet fighters delivered to West German air force are shown in formation over Germany; total F-model order is 30 and 16 have been built at Burbank, Calif., so far. Lockheed also will build 66 single-place F-104Gs with first to enter flight test at Palmdale in October and delivery is set for January, 1961. F-model order will be completed next September.

PICTURE CREDITS

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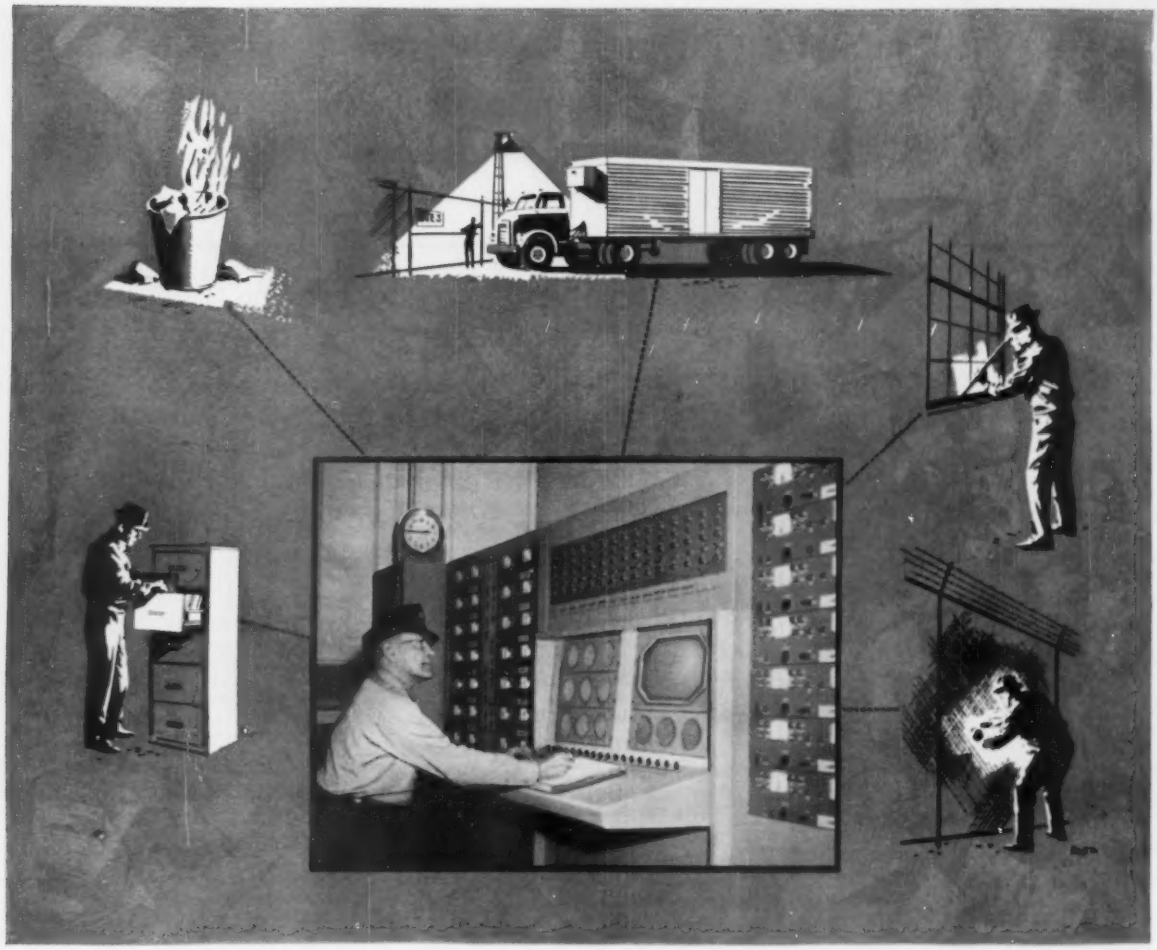

How Honeywell electronics improves classified area protection and lowers costs!

This completely new concept in protective systems enables one guard to do the work of many—more effectively. From a central control panel, he can instantly check the security of any building or area—even remote gates 20 miles or more away. Through electronic signals, the system employs all three means of detection—*physical* break in, *audible* noise created by the intruder and *motion* by anyone concealed within the area. It detects any form of illegal entry, loitering, vandalism and sabotage, as well as fire. And it can provide complete surveillance of temperature, refrigeration, lights, boilers and flows.

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EDITORIAL

Top Priority for Military Space Systems

The diplomatic obsolescence of the U-2 and other forms of manned aerial photography over unfriendly territory and the success of the USAF Midas early warning satellite development test operation have focused the international spotlight on the rapidly increasing importance of military space systems.

It is interesting to note that only a few short months ago we were still getting pontifications from our highest political leaders that there was no foreseeable military value in space. We are not likely to hear any more of this technically naive bilge since the demise of the U-2 generated an urgent national requirement for an effective surveillance system that can operate beyond the range of contemporary enemy defenses and beyond the pale of diplomatic entanglements. This system must also operate with the round-the-world every 95 min. speed of a satellite rather than the much slower pace of the U-2 photographic transmission belt.

The Midas, with its infrared detection system, the Samos, with a capability for photographic and electronic reconnaissance, and the Courier communications satellite together offer a solid technical hope for the creation of a military space system that will provide the best warning yet of a potential enemy's aggressive operations. In this uneasy age in which we live an almost instantaneous knowledge of a potential enemy's movements and his certain knowledge that we have the capability to obtain this knowledge is one of the more effective forms of deterrence from any aggressive operations.

It is appropriate to note here that many of our military and aerospace industry leaders were far more alert to the requirement for this type of reconnaissance-intelligence space system and much more aware of its technical feasibility than the political leaders, who until recently scoffed so scornfully at the military use of space.

The original USAF WS-117L satellite reconnaissance program, variously called "Big Brother" and "Sentry," antedated the first Soviet Sputnik by considerable time. It is this program that, after interminable delays through management reorganizations in the upper layers of Pentagon bureaucracy, finally emerged as the Discoverer research and development program aimed at providing the technology for Midas, Samos and Courier operational systems. Details of this research and development program can be found on page 57 of this issue in a report on USAF's 6594th Satellite Test Wing at Sunnyvale, Calif., by AVIATION WEEK associate editor Russell Hawkes.

Most of the space technology achievements recorded under the U. S. flag since Sputnik have been laid on a foundation of ballistic missile technology developed by USAF's Ballistic Missile Division and its industrial and scientific contractors, although this fact has been largely obscured by a national public relations policy of throwing a civilian cloak over the application of this military effort in space research.

The record shows that, of the 19 U. S. satellites put into orbit, 12 were launched by BMD crews using the Thor and Atlas as boosters. Three of the five Pioneer space probes were also launched by BMD crews with USAF boosters. The Discoverer, Tiros, Transit and Midas shots have demonstrated the precision guidance of a payload into predetermined orbits, stabilization of vehicles on an orbit so that they are in a constant attitude to the earth, regular communications from deep in space, restart of liquid rocket engines in space and transmittal of specific data on ground command. There are still many technical problems to be solved before a space surveillance system will achieve the operational reliability required by a military operation, in contrast to exploratory research space vehicles, and before it can produce data of sufficient detail to equal the current performance from reconnaissance aircraft operating within the atmosphere's envelope.

Many people apparently are under the impression that the development of these space systems into operationally-useful military systems is being pushed with top priority and all the speed possible.

Unfortunately, this is not true.

It is generally agreed in technical circles that the current state of the art on space systems is now far more advanced than was that of ballistic missile technology when the decision was made in 1955 to proceed with a policy of concurrency, developing the ICBM as weapon systems from the very start of the program. It was this policy of doing the research and development concurrently with the development of support, operational and logistics systems for these vehicles to be used as a combat-ready weapon system that brought the ICBM from the technical incubator in 1955 to initial operational capability in 1960—a phenomenally short lead time for any combat system.

Yet, this same policy has been discarded for the space surveillance systems. Valuable time is being lost as a result in an era when this commodity was never more vital and precious.

In addition, the research and development phase of the program is still being retarded by a penny-wise, pound-foolish budget policy that has delayed construction of adequate launch pads and ground tracking, data reduction stations.

Even the Pacific Missile Range ships cannot track Discoverer satellites and their ejected data capsules because fund restrictions have cut the necessary tracking equipment from their decks.

It is time that we recognize the contribution that military space surveillance systems can make to the preservation of peace in the missile era and push their development at top priority with a streamlined military-industrial management team that can achieve significant results within a time span to be truly effective.

—Robert Hotz

On the new J85 Jet Engine: Lightweight, dependable Kidde high-temperature actuators!

In order to move the variable exit nozzle on the afterburner of the J85 engine, G.E. uses three lightweight Kidde ball screw actuators, similar to the unit shown above. Each actuator employs a ball screw mechanism that weighs only 0.6 pounds and has a shaft diameter of ½ inch.

The Kidde ball screw actuator shown can carry loads up to 1,400 pounds and can operate continuously in a temperature range of from –65° F. to +840° F. At high temperatures, these mechanical ball screws are more reliable than electrical, pneumatic or hydraulic systems. Because they have a minimum amount of back-lash and friction, they can easily perform functions calling for the rapid reversibility of heavy loads. This makes them especially suitable for applications such as thrust reversal, gimbaling rocket or jet engines, atomic scramshaft controls and space flight controls.

Like G.E., you, too, may have a problem which can be solved with Kidde ball screw actuators. For more information on these dependable actuators, write Kidde today.

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G. Ray Woody and **Hoadley Dean,** appointed to board of directors of Frontier Airlines, Denver, Colo.

Ernest N. Ljunggren, vice president-Minuteman Systems Management Division of Autonetics, Division of North American Aviation, Inc., Downey, Calif.

Honors and Elections

John E. Sorenson, research meteorologist, United Air Lines, Denver, received the Edgar S. Gorrell Award of the Air Transport Association for 1959.

Oscar Bakke, director of the Bureau of Flight Standards of the Federal Aviation Agency, received the Wagner College Alumni Association's 1960 Achievement Award.

(Continued on page 97)

INDUSTRY OBSERVER

► More effective communications between deep space probe vehicles and earth will be possible using an "RF-seeker" under development by Jet Propulsion Laboratory which will automatically orient the vehicle's antenna toward earth using an adaptation of radio direction finding techniques.

► **Martin Co. has found in tests at Denver that primer cord used in destruct systems for missiles burns at one-third its normal velocity at liquid hydrogen temperatures. Velocity, however, is still rapid enough to destroy a missile within prescribed safety limits.**

► Specialists in design of photo-reconnaissance equipment, who have been studying miniaturization of the present bulky and heavy systems, believe the entire photo-reconnaissance requirement for any aircraft installation could be built into a unit of about 120 lb. Technique would be to use all-transistorized cameras and control gear and to switch from current 9-in. film widths to standard 2¼-in. size.

► **Pitch-up inhibitor installed on the McDonnell RF-101C has almost eliminated that form of instability from the aircraft's flight characteristics. Unit is a simple vaned probe mounted on each side of the fuselage below and forward of the cockpit. It senses incipient pitch-up, warns the pilot with a horn and then feeds 25-lb. nose-down stick force into the control system.**

► Requirement that lunar impact payloads be completely sterilized to prevent contamination of the moon's surface by baking the payload at temperatures of 125C for 24 hr. may pose hurdles for some avionic components such as germanium semiconductors, vidicon tubes and magnetic tape.

► **Lockheed F-104G being developed for West German air force will carry reconnaissance pod as an external store. Pod will contain standard photo-reconnaissance equipment featuring in-flight processing of negatives. Pod will include side-looking radars and an infrared reconnaissance capability.**

► Lycoming Division of Avco Mfg. Corp. is developing ungeared IO-720 and geared IGSO-720 eight cylinder fuel injection piston engines, as extensions of the Lycoming 540 series. IO-720 is 450 hp. and IGSO-720 is 520 hp.; both are programed for 1961. Negotiations for an order of about 50 IO-720s for use in Sicilian-built Doman LZ-5 helicopters are under way between Lycoming and Raoul Turola, of Aeronautical Society of Sicily, firm headed by Italian designer Angelo Ambrosini (AW Feb. 1, p. 49).

► **Operational versions of Navy's Transit navigation satellite systems probably will be placed in orbits of 28 deg. and 50 deg., although 22½ deg. and 67½ deg. orbits would better from a theoretical standpoint. Former orbits, however, provide longer life, higher safety factors. Navy plans to put two satellites in each orbit to provide almost continuous around-the-world navigational information.**

► Air Force maintenance crews of the 576th Strategic Missile Squadron have run their second Atlas through a periodic overhaul at Vandenberg AFB, Calif. Procedure, which calls for bringing the ICBM into the missile assembly building on the base every six months, requires approximately four-to-six weeks to complete at the present point on the maintenance crews' learning curve. Eleven men are now assigned to an Atlas periodic maintenance crew.

► **Major operational problem envisioned under Navy's Dash program for installing unmanned helicopters aboard destroyers for anti-submarine search missions appears to be the difficulty of retrieving the vehicle, particularly in rough water operations. Helicopter range under the concept is programed for approximately 20,000 yards.**

► Indonesian air force is expected to order a number of armed Beech T-34 Mentor primary trainers built under license in Japan by Fuji Heavy Industries, Ltd., for use in rebel skirmishes. Armament under consideration is 0.3 in. machine guns manufactured by Japan Special Steel Co. Indonesians may also decide to order 40 of standard T-34s for regular training missions.

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CANNON PLUGS

Washington Roundup

U-2 Repercussions

Republican handling of the U-2 incident and summit debacle will join defense policy as a major election campaign issue. Democrats served notice last week that they plan to discuss these issues fully in the coming months. Summit crisis injected fresh controversy into a defense issue that had been muted in recent weeks.

Evidence mounted that defense spending will be increased in the next fiscal year as a result of the summit failure. Senate Armed Service Appropriations Subcommittee will hear USAF Chief of Staff Gen. Thomas D. White and other service chiefs in closed sessions before changing the budget.

Gen. White has given two additional Atlas squadrons top priority in any budget increases. Earlier bid to add $250 million for two squadrons lost by one vote in the House Appropriations Subcommittee. Gen. White rejected Senate proposals for a bigger Titan program because the extra Titans could not be in service before the Minuteman solid-propellant ICBM.

Recent Bomarc-B test successes have improved the congressional outlook since the House cut $294 million from the program. House Military Appropriations Subcommittee approved the cut by a close vote during a period of Bomarc-B test failures.

More money for the B-70 is a good bet. There is strong Senate support for USAF's request for an extra $285 million, and the House is likely to go along to the extent of about $50 million to ease the financial pinch. The program already has run into a $20 million shortage.

Senate Majority Leader Lyndon Johnson is pressing for an increase in the B-58 program. Gen. White conceded he would like to double the present 116 bomber program if there were no budget ceilings.

Congressional approval seems certain for a $250 million MATS modernization fund. Army Secretary Wilber M. Brucker strongly supported the money added by the House for interim transports, possibly the cargo KC-135 and long range C-130B.

Navy is concentrating on its drive to get $293 million for a carrier restored to the budget. Strategy is to push for the carrier instead of increased Polaris funds, then go back for more Polaris money in a supplemental request early next year.

Bilateral Stalemate

U.S.-British bilateral negotiations appear stalemated at least for the moment. British delegation apparently was under stiff orders to make no concessions on U.S. rights beyond London during recent talks in Washington. U.S. has little to bargain with, since the British already have won all their major route goals. This leaves TWA still without its Frankfurt-Zurich link beyond London and Northwest still not in Hong Kong.

Sen. Spessard Holland is conducting a personal inquiry into NASA's choice of Douglas Aircraft to develop the S-IV stage of Saturn. His inquiry could grow into a demand for investigation of space agency contracting practices.

Inquiry is sparked by Sen. Holland's concern over loss of business for his Florida constituency. At least one bidder, Chrysler Corp., agreed to build a Florida facility if it won the contract. Sen. Holland questions the choice of a company that will have to ship the S-IV through the Panama Canal for testing at Huntsville, Ala., and Cape Canaveral, Fla. He also said Douglas' bid was "considerably" higher than others.

NASA defends the contract award on grounds of technical merit. The agency said studies indicate transportation will account for only 1% of total costs.

British Missile Talks

British Defense Minister Harold Watkinson will discuss buying Skybolt and Polaris missiles during his U.S. visit this week. British are looking for mobile missile systems to replace their canceled Blue Streak ballistic missile. Skybolt would be used to extend the life of British bombers. Polaris could be used at sea or adapted to railway use.

Pressure for changes in federal regulatory policy and practices grew in the Senate last week. Disturbed by recent appointments to various agencies, Sen. Kenneth Keating plans to introduce a bill soon which would establish a National Advisory Commission on Administrative Practices and Procedures. This group would study such material as the critique of former CAB Member Louis J. Hector, Hoover Commission reports and past legislation, then draft a long-range plan for attracting better qualified men to government service.

Senate Commerce Committee joined the critics of the current regulatory approach with plans for a sweeping investigation of all agencies, including CAB, next year. Sen. Warren G. Magnuson, committee chairman, said this probe will emphasize improvement of the laws under which the agencies operate, rather than highlighting conflict-of-interest issues with individual board members.

—Washington Staff

Titan, Atlas May Boost Rover Rocket

Use of Saturn for flight-tests of nuclear rocket also may be proposed under NASA study contracts.

By Michael Yaffee

Use of Titan and Atlas as flight-test vehicles for the Project Rover nuclear rocket is considered feasible and is expected to be a prime topic in studies developed by winners of a new NASA Nuclear Rocket Flight Test System Study competition (AW May 9, p. 25).

Other possibilities that will probably be studied are use of the Saturn and direct ground launching of the Rover without chemical boosters. The latter approach, however, is considered unlikely in light of potential radiation hazards and the high anticipated weight of the nuclear propulsion system which is expected to give the first Rover rockets a thrust-to-weight ratio of less than one. Use of the Saturn in initial flight tests will depend upon its availability.

Object of NASA's Nuclear Rocket Flight Test System studies is to define the initial Rover flight test program, with investigation and evaluation of techniques and ground support equipment as well as of actual flight vehicles.

Of the 30 companies that attended the recent bidders' conference, approximately 20 are expected to submit proposals, some as teams. Included are at least five major airframe companies—Lockheed, Martin, Convair, Douglas and North American. Deadline for the bids is May 31. After evaluating them, NASA will award three study contracts for $1 each and two for approximately $150,000. Much to industry's dislike, the winners of the funded studies will probably be asked to contribute some time and money of their own to the project. But the winners are expected to have an inside track on later test programs and development contracts. Study contracts also mean the long-sought access to Atomic Energy Commission data for the recipients.

Air Force is expected to announce the winners of its two new share-the-cost nuclear rocket study contracts shortly. These will be omnibus studies covering a range of first generation nuclear rocket propulsion systems, including the Rover as well as somewhat more sophisticated systems.

Purpose of the studies will be to provide the Air Force with nuclear engine performance data—including costs, hazards, availability, etc.—that can be funneled into the various vehicle study requirement contracts for different projected missions that the Air Force has already awarded. Presently without any role in nuclear rocket development, the Air Force is studying this work closely for possible future applications.

Aim of the joint NASA-Atomic Energy Commission effort on Project Rover is orbital flight test of a prototype nuclear rocket on top of a Saturn launch vehicle in 1965, according to Maj. Gen. Don R. Ostrander. Several suborbital flight tests, probably using Titan or Atlas boosters, are expected to precede this. From their work in earlier studies such as the unpaid Air Force effort SR 150, several aircraft companies are convinced that existing ICBMs will serve adequately as sub-orbital boosters for early Rover flight vehicles.

Martin Co., for example, has already developed a configuration based on the Titan first stage. Nuclear second stage of this configuration was predicated on Rover technology; and while actual purchase requirements of the current NASA competition may necessitate some projection of this work, the company feels that it nevertheless has demonstrated the basic capability of the Titan to do the job.

Initial nuclear rocket propulsion systems are expected to prove relatively crude and heavy affairs. The first units reportedly will be designed to fire for approximately five minutes, achieving a specific impulse of 750 sec. and a thrust of 50,000 lb. Engine will weigh about 10,000 lb. and, including propellant, tankage and other hardware, over-all weight of the first Rover rockets is expected to exceed 50,000 lb. Rover will be designed for a thrust-to-weight ratio greater than one; its over-all weight will drop as the system is refined.

Basically the Rover is classified as a heat transfer nuclear rocket. Liquid hydrogen propellant or working fluid is pumped through a reactor core, where it will pick up heat from the fissioning of uranium atoms, and is then ejected through a rocket nozzle to produce thrust. Heart of the system is the reactor which will be based on AEC's work with the Kiwi (see p. 89). Kiwi is an intermediate (this refers to the speed of the neutrons which are the main source of fission) reactor which, in flyable form, will be three to four feet in diameter and positioned just ahead of the nozzle.

Fuel elements in the Kiwi reportedly will be uranium-enriched graphite. These will be short-lived elements and the engine will not have restart capability. Some sort of control mechanism, possibly neutron absorbing rods, will be used to regulate power level and temperature.

Introducing a new element into the aerospace industry, Atomic Energy Commission will build the prototype reactors. Then, if AEC follows the pattern set with submarine reactor development as the industry expects it to do, companies will be asked to bid on reactors with specifications closely defined by AEC.

With each succeeding reactor project, companies will be allowed more freedom in development.

For the future, government and industry are already thinking about nuclear rocket engines both larger and smaller but more sophisticated than the Rover. When fuel elements are

Nuclear Plane Funds

Washington—Fiscal 1961 research and development funds for work on aircraft nuclear propulsion systems were approved by the House last week after the Appropriations Committee, following the collapse of the Paris summit meeting, rejected a subcommittee recommendation that the entire $75 million requested for this purpose by the Atomic Energy Commission be killed.

In restoring the funds, however, the committee placed a limit of $58 million to be used in the nuclear propulsion program, holding expenditures to the Fiscal 1960 levels. The House already has approved $75 million in the Defense Department budget, making a total of $133 million available in the joint Defense Department-AEC aircraft nuclear propulsion program for Fiscal 1961.

Funding of the ANP program was questioned by the Appropriations Committee during original consideration of the defense budget, and a special subcommittee was appointed by Committee Chairman Rep. Clarence Cannon (D.-Mo.) to consider the AEC's request for $73 million in the Public Works appropriations.

The subcommittee said the Defense Department may soon be able to make a selection between General Electric's direct cycle and Pratt & Whitney's indirect cycle concepts and, once a decision is made, there would be no need for all of the funds proposed.

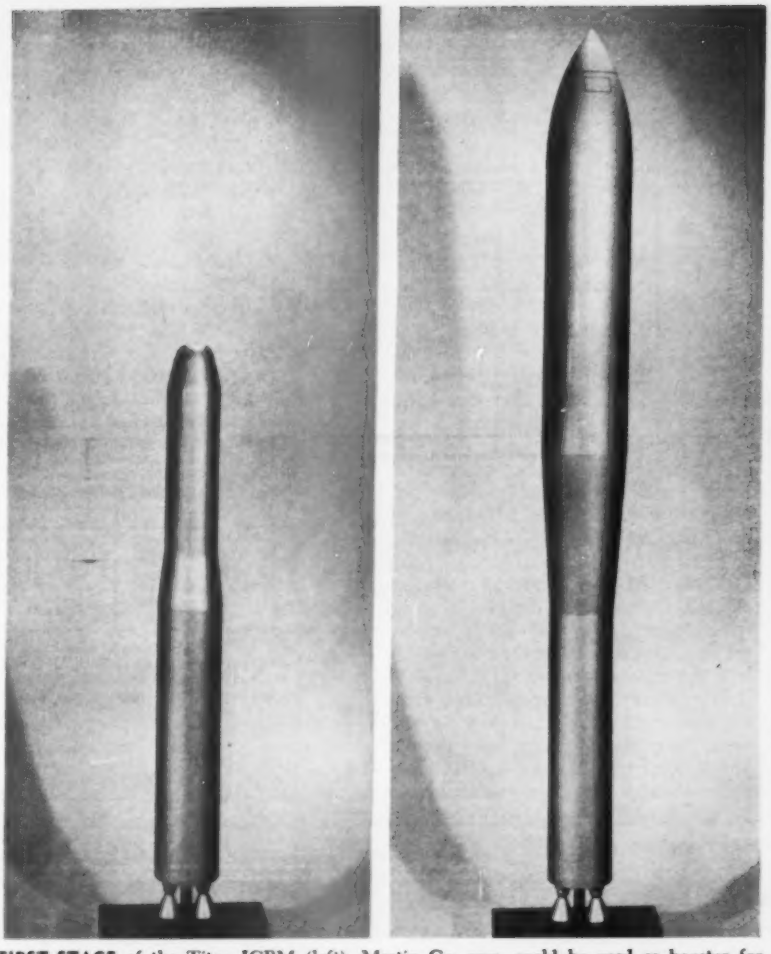
developed that are capable of withstanding the required higher temperatures, engineers and scientists are sure that nuclear rocket engines can be built that will have specific impulses of 800-900 sec.

Atomic Energy Commission reportedly is keeping its Condor project alive, although for the present it is at a low research level. This is believed to be a program for the development of a flyable nuclear rocket system that could develop 10 times more thrust than the Rover, or approximately 500,000 lb. Patterned after the Kiwi, the Condor reactor would probably have short-lived fuel elements and no restart capability. Like Rover, Condor will be designed with a thrust-to-weight ratio greater than 1 for use in gravitation fields.

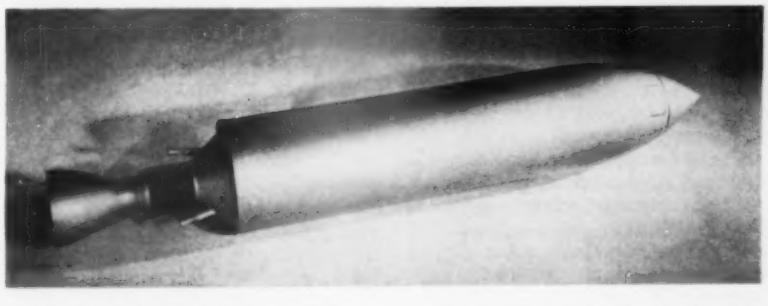
Others in the military services and in industry are now showing a great deal of interest in what the Martin Co. calls nuclear rocket sustainer engines. As differentiated from the Rover type system (which some engineers are calling nuclear booster rockets), nuclear sustainer rocket engines will be designed for long duration, stop-start operation in planetary orbits or space where gravity effects are negligible. Suggested applications for such engines include orbit trimming, orbit transfer, anti-satellite warfare (that is, as powerplants for satellites that could intercept and inspect enemy satellites), and as engines for space ferry and rescue vehicles.

Sustainers would have thrust-to-weight ratios considerably under 1, possibly as low as 10^{-4}. For minimum size and weight, they would probably use fast reactors about half the diameter of the Kiwi intermediate type units. Fuel elements, which would have to last for five to 10 hr. instead of just 5-10 min., would probably be clad with the refractory metals tungsten or tantalum. A considerably enriched uranium fuel would be used in place of the Kiwi's uranium-graphite fuel in order to obtain a self-sustaining reaction. To promote dissociation of the hydrogen and thereby raise specific impulse, possibly to over 1,000 sec., the nuclear propulsion system would be operated at low pressures.

Considerably more sophisticated than Rover type nuclear rockets, nuclear sustainer rocket engines also entail considerably more difficult development problems. For one thing, comparatively few fast reactors have been built for any purpose and little is known about this technology. Fast reactors are harder to control than slow or intermediate reactors. They operate without moderators to slow the neutrons and so the time from fission to absorption is much shorter. This means that the control mechanisms for regulating temperature and power level will have to be faster and more precise.



FIRST STAGE of the Titan ICBM (left), Martin Co. says, could be used as booster for a suborbital Project Rover nuclear rocket flight test vehicle (right). Above models, which are to the same scale, show Titan in regular two-stage ICBM configuration and with a nuclear rocket and new adapter section in place of its second stage. Martin's nuclear rocket second stage, shown below without adapter section, is based on Project Rover technology. Reactor is located between nozzle and liquid hydrogen tank. Two small projections on opposite sides of the reactor are vernier nozzles.



Tied in with this is the problem of thrust control, since the propellant will be used as a cooling agent for the fuel elements with the rate of flow regulating element temperature as well as rocket thrust. Aftercooling also creates a problem for the nuclear sustainer engine. After the reactor is shut down, the radioactive isotopes that have been formed continue to generate heat that must be dissipated.

As one company that is already working on some of the problems of nuclear sustainer rocket engines, Martin, estimates that technology in this area is about five years behind that of the Rover type rocket systems. The first flight of a nuclear sustainer could be made in 10 years, Martin engineers maintain, and nuclear sustainer rockets could possibly be operational in about 15 years.

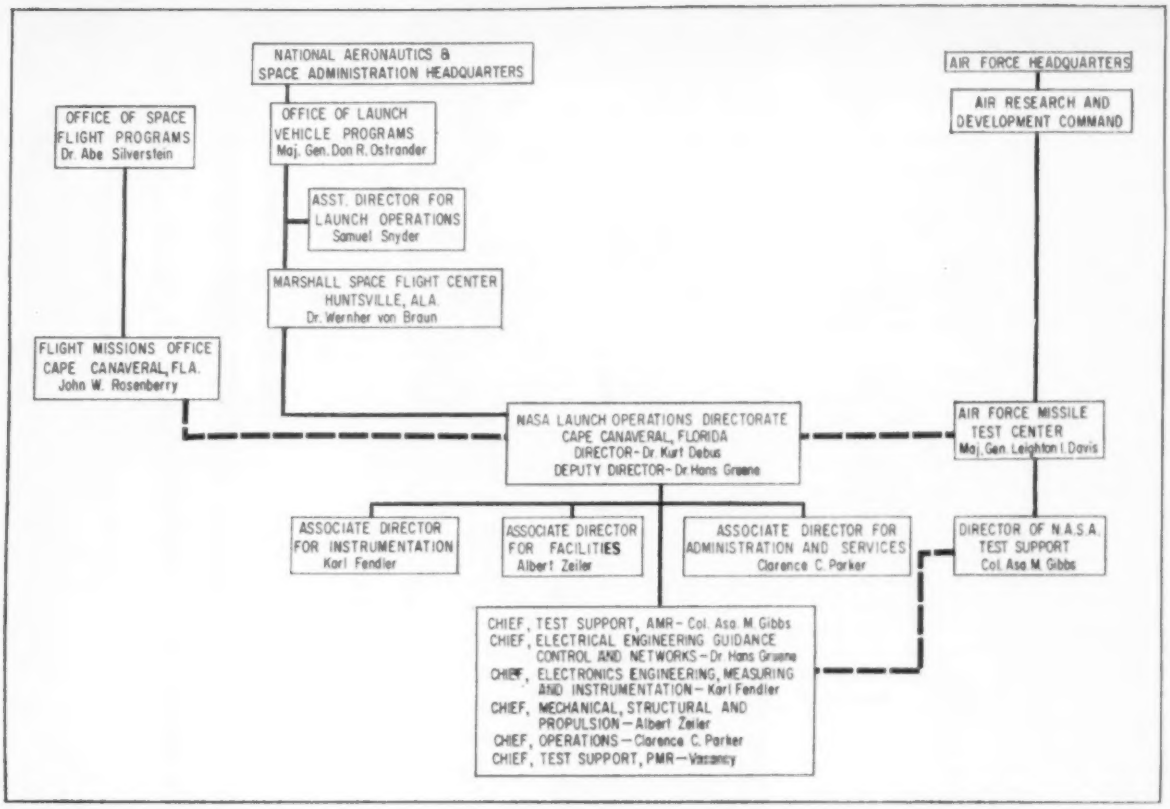

NATIONAL AERONAUTICS & SPACE ADMINISTRATION HEADQUARTERS
AIR FORCE HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
OFFICE OF SPACE FLIGHT PROGRAMS Dr. Abe Silverstein
OFFICE OF LAUNCH VEHICLE PROGRAMS Maj. Gen. Don R. Ostrander
ASST. DIRECTOR FOR LAUNCH OPERATIONS Samuel Snyder
MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA. Dr. Wernher von Braun
FLIGHT MISSIONS OFFICE CAPE CANAVERAL, FLA. John W. Rosenberry
NASA LAUNCH OPERATIONS DIRECTORATE CAPE CANAVERAL, FLORIDA DIRECTOR - Dr. Kurt Debus DEPUTY DIRECTOR - Dr. Hans Grsene
AIR FORCE MISSILE TEST CENTER Maj. Gen. Leighton I. Davis
ASSOCIATE DIRECTOR FOR INSTRUMENTATION Karl Fendler
ASSOCIATE DIRECTOR FOR FACILITIES Albert Zeiler
ASSOCIATE DIRECTOR FOR ADMINISTRATION AND SERVICES Clarence C. Parker
DIRECTOR OF N.A.S.A. TEST SUPPORT Col. Asa M. Gibbs
CHIEF, TEST SUPPORT, AMR - Col. Asa M. Gibbs
CHIEF, ELECTRICAL ENGINEERING GUIDANCE CONTROL AND NETWORKS - Dr. Hans Gruene
CHIEF, ELECTRONICS ENGINEERING, MEASURING AND INSTRUMENTATION - Karl Fendler
CHIEF, MECHANICAL, STRUCTURAL AND PROPULSION - Albert Zeiler
CHIEF, OPERATIONS - Clarence C. Parker
CHIEF, TEST SUPPORT, PMR - Vacancy

CHART SHOWS reorganization of NASA's launching operations, relationship of new directorate to other centers and headquarters offices.

Space Technology

NASA Centralizes Launch Management

By Evert Clark

Washington—National Aeronautics and Space Administration, which is rapidly becoming a major user of the nation's missile ranges, moved today to simplify its complex organization for handling space vehicle launchings that are expected to total 25 to 35 a year over the next three years.

A new Launch Operations Directorate began interim operation at the Atlantic Missile Range, where it will serve as the coordination point not only for firings from Cape Canaveral, Fla., but eventually from the Pacific Missile Range as well.

Director of the new office is Dr. Kurt Debus, former chief of Army Ballistic Missile Agency's Missile Firing Laboratory. By choosing Debus, NASA prepares for the integration of his 400-man laboratory into the agency on July 1, when the new directorate will become fully operational.

NASA also gains the benefit of Debus' long experience, which extends back through Pioneer and Explorer space vehicles and satellites and the Pershing, Jupiter and Redstone missiles to the German V-2 of World War II.

Debus' office reports to Dr. Wernher von Braun, director of the new Marshall Space Flight Center at Huntsville, Ala., which is being formed around von Braun's old ABMA Development Operations Directorate. Both Marshall and Debus' office are under the supervision of the Office of Launch Vehicle Programs at NASA headquarters, which was created last fall (AW Oct. 26, p. 28) when the decision was made to transfer the von Braun team and the Saturn super booster to the civilian agency. This office is headed by Air Force Maj. Gen. Don R. Ostrander. Assistant Director for Launch Operations is Samuel Snyder.

The move essentially gives Debus direction over launching operations for all Thor-Agena, Atlas-Agena, Atlas-Centaur and Saturn vehicles from either coast.

Two major programs are exempted from this general pattern—Project Mercury and the Thor-Delta program. At least for the time being, NASA's Wallops Island, Va., launch site will remain under the Office of Space Flight Development headed by Dr. Abe Silverstein, and the major vehicle to be launched from there—the solid propellant Scout—will remain under Langley Research Center.

Ostrander and Silverstein divide responsibility on a launching. Silverstein in most cases is responsible for payload and spacecraft development, through Goddard Space Flight Center or Jet Propulsion Laboratory. Ostrander is responsible for launching through injection into orbit or into a space trajectory. Silverstein's office then is responsible for acquisition and reduction of data.

To coordinate range support requirements of the NASA field centers that provide the payloads, a Flight Missions Office also has been created at Canaveral. It is headed by John W. Rosenberry and will report to Silverstein. However, it will submit range requirements through Debus' office to keep the range commander's contact points with NASA down to one.

There also will be a Directorate of NASA Test Support on the staff of the Atlantic Missile Range commander, USAF Maj. Gen. Leighton I. Davis, just as there are directorates for the three military services. It will be headed by USAF Col. Asa M. Gibbs, formerly at Air Research and Development Command's Ballistic Missile Division. Gibbs also will wear a NASA hat as chief of Debus' Test Support Department.

As complex as the new arrangement may seem, it is expected to be a welcome simplification to the several thousand people affected at AMR, to NASA centers themselves and to contractors in the space field. It is one of the last of NASA's major organizational mare's nests to be straightened out, and one of the most important to NASA's success.

Late in 1958, when NASA was created, Administrator T. Keith Glennan sent one man, Melvin N. Gough, to Cape Canaveral as his personal representative to Maj. Gen. Donald N. Yates, who was then commander of the Air Force Missile Test Center and the range.

Programs Introduced

NASA, accustomed to doing research, was faced with learning how existing military launching systems and facilities worked, how Air Force wanted programs introduced into the range, etc., and, at the same time, organizing an agency and introducing itself rapidly into existing USAF and Army lunar probe projects and Navy's Vanguard program.

Within a few months, the Mercury and Delta programs and a number of assorted space shots were added to NASA's burden, with subsequent demands for more hangar space, pad space, payload checkout space, etc.

Some of the Vanguard team remained with Naval Research Laboratory but most of it joined NASA. Jet Propulsion Laboratory, which had been Army's teammate, separated from Army and joined NASA, changing the JPL-Army relationship. In launch programs involving Air Force-developed boosters, NASA sometimes dealt directly with contractors, sometimes through BMD and Space Technology Laboratories to the contractors, and sometimes directly from headquarters to an ARDC-BMD office, as in the Agena and Centaur programs.

As NASA gained vehicle programs from the services, sometimes shifting them from one office to another after it had acquired them, the picture grew still more complex. When the decision was made to transfer the Army missile team to NASA, it was put under Ostrander's launch vehicles' office But JPL, Army's former partner, was now under Silverstein's space flight office. The Delta program, handled by the old Vanguard group under Silverstein's supervision, called for launchings from both coasts. And, to add to the confusion still further, ARDC reorganization called for eventual supervision of the Atlantic Missile Range by Ballistic Missile Division.

"The range cooperated," one NASA launch official told AVIATION WEEK, "but it was baffled. It didn't know whether our continuing requirements made sense."

Meanwhile, Gough's Atlantic Missile Range Operations Office grew to a dozen people but NASA's total complement at the Cape—made up primarily of personnel from the Mercury Space Task Group and Goddard's Delta group—grew to about 105.

The need to integrate the Missile Firing Laboratory in NASA's Cape operations and the fact that it was the largest single launching group with the most experience, made it a natural focal point for all NASA range requirements.

Now that launch operations procedures have been established and a permanent organization has been created to replace the AMROO, Gough has been transferred to headquarters to serve as Flight Operations Coordinator for Edmond C. Buckley, assistant director for space flight operations. He will coordinate tracking requirements with other agencies and ranges.

Debus' deputy director is Dr. Hans Gruene. Associate directors are Karl Fendler for instrumentation, Albert Zeiler for facilities and Clarence C. Parker for administration and services.

The launch directorate also will have these departments:

- **Test Support,** with Col. Gibbs as chief.
- **Test Support for the Pacific** Missile Range, a post that is now vacant.
- **Electrical Engineering,** Guidance Control and Networks, with Gruene as chief.
- **Electronics Engineering,** Measuring and Instrumentation, with Fendler as chief.
- **Mechanical, Structural** and Propulsion, with Zeiler as chief.
- **Operations,** with Parker as chief.

Debus also will have a Technical and Scientific Staff and a Project Coordination Staff. The latter will supervise the completion of the Missile Firing Laboratory's current obligations to the Army on the Jupiter, Pershing and Redstone programs.

Requirements of the Saturn, Centaur, Agena and other project directors at Marshall will be funneled into the new directorate through the Project Coordination Staff, which will pass them to the technical divisions. When detailed requirements have been drawn, they will go back through the coordination staff and into Col. Gibbs' USAF directorate to be broken into range documentation for facilities, resources, etc.

Debus' authority over Mercury and Delta is limited because both are far enough along that their program organization already is well set. Walter Williams, deputy for operations at the Space Task Group, will direct the Mercury work at the Cape, and worldwide tracking and recovery will not come under Debus' office. Delta work at the range will be under the supervision of Goddard's Fields Project Branch headed by Robert Gray.

Facility Needs

NASA wants one main cluster of buildings on Cape Canaveral to simplify operations and communications and to have a readily identifiable NASA area. In anticipation of the creation of the directorate, NASA recently stopped the mushrooming of buildings and other facilities to give Debus a chance to coordinate requirements.

The agency has asked Congress for $27,750,000 in Canaveral facilities' money for Fiscal 1961. This would include completion of the Saturn launching complex, including a new pad (AW Apr. 18, p. 26); a hydrogen facility; a staging building, and an addition to an engineering and laboratory building.

Debus will have varying levels of responsibility in each program. With specific exceptions, including Mercury and Delta, he will be the over-all boss in the blockhouse during a launching. He will have ultimate veto authority to override the project chief and insist on scrubbing a launching, but the project chief also can scrub a test if he is not satisfied.

The NASA directorate will occupy the old Missile Firing Laboratory building and will have its own visitor control, security control, etc. Public relations will operate from the directorate but will report directly to the public relations director in headquarters.

Reliability Review

Washington — National Aeronautics and Space Administration is considering having outside contractors make specific design analyses of launching vehicles to help increase reliability. Existing vehicles already receive an extensive study from in-house NASA groups which also include members from the Bureau of Standards or other government agencies, but firms such as Arinc Research Corp. are being considered for a second review.

Juno II vehicle, which has had three failures in six shots, currently is being given a design wringing out before the final four are used for satellite shots.

GAO Lists Objections to Management Plan

By Katherine Johnsen

Washington—General Accounting Office recommended last week that the Air Force take over the scientific and engineering personnel of Space Technology Laboratories, fully-owned subsidiary of Thompson Ramo Wooldridge, Inc., and develop "in-house" technical and management direction of its ballistic missile and space programs.

In a report submitted to Congress, the President and the Secretary of Defense, GAO's basic argument is that technical recommendations and decisions largely determine management decisions—which directly affect the activities of many major contractors, hundreds of subcontractors and thousands of third-tier contractors and vendors—"and should be made by the Air Force rather than outside organization, profit or nonprofit."

USAF could save money, GAO maintained, by directly hiring Space Technology Laboratories' employes and eliminating the fee paid to STL. GAO proposed "appropriate salaries and incentives" above the civil service level for these employes, if necessary. As an example of precedent, GAO pointed out that 450 scientific positions in the $12,500 to $19,000 a year salary range have been authorized for Department of Defense.

"Whether the staff be government or contractor employed, the government will pay the cost of these professional services, plus a fee if a contractor is involved," GAO said. Fees paid STL and its former parent firm, Ramo-Wooldridge Corp., from May, 1954, through June 30, 1960, will total over $14.5 million, according to GAO. With the separation of STL as a corporate entity in 1958, the remainder of Ramo-Wooldridge was merged with Thompson Products.

USAF's plan to convert STL into a nonprofit organization, purchasing facilities estimated at $20 million to $30 million from Thompson Ramo Wooldridge (AW May 16 p. 36), GAO said, "would overcome some of the problems," including conflicts between STL and production contractors and extremely high STL stock earnings over a brief period. GAO added that "we nevertheless believe that the function of systems engineering and technical direction in a program of this magnitude is so closely interwoven with the management of the program itself and is so broad in scope that it more appropriately should be performed by a government agency."

The outlook is that the Air Force will move forward with its plan to convert STL to nonprofit status without congressional intervention in view of its expected July adjournment, the advanced status of the USAF plan and the fact that it will correct the two major congressional objections to STL's role as a profit organization—the conflict between STL and manufacturers and the stock profits of its officers and employes.

Air Force initiated action to convert STL to nonprofit status following a report last fall by the House Military Operations Subcommittee headed by Rep. Chet Holifield (D.-Calif.), demanding that this be done if STL is continued as technical director of USAF ballistic missile programs (AW Sept. 14, p. 146).

The general view of members of the Holifield subcommittee and other key congressmen appears to be that the Air Force should have taken steps to further develop its "in-house" capability over the past five years—a point highlighted in the GAO report—but that so long as this has not been done, it is a tossup between the nonprofit arrangement and development of a USAF in-house staff. Several congressional committees will carefully review the specific provisions for converting STL to nonprofit status, particularly payments to Thompson Ramo Wooldridge for facilities and salary scales. Salaries paid STL technical personnel have substantially exceeded those paid by other electronics and aeronautical firms, and research institutes.

Withdrawal Predicted

GAO pointed out that Ramo-Wooldridge Corp. withdrew as a USAF technical director so that it could utilize its technical knowledge on production contracts and warned that STL is likely to do the same.

Eleven of the 14 top executives "who undoubtedly had acquired a wealth of knowledge of value" during Ramo-Wooldridge's five years of participation in the ballistic missile program, moved to Thompson Ramo Wooldridge after merger, while three joined STL.

"As STL's know-how grows through continued systems engineering and technical direction, it would appear that the financial incentive to withdraw from the program would become increasingly pressing, while the Air Force would become increasingly dependent on the capability acquired by STL," the GAO report said.

Although STL is barred from manufacturing activities related to its role as technical director in the ballistic missile program, GAO said "the likelihood that the know-how being developed may be used by (STL) to compete for production in related fields and in future programs in a deterrent to full cooperation by the participating contractors. This handicap to complete exchange of information would be avoided if the systems engineering and technical direction were performed by a government staff."

GAO listed three examples of production contracts obtained by either Ramo-Wooldridge or STL that were closely related to ballistic missile programs:

- **$4.3 million USAF contract** for development of the Pioneer lunar flight vehicle, which utilized the Thor intermediate range ballistic missile for the first stage.
- **$800,000 subcontract from** American Bosch Arma Corp. for data processing equipment for the Titan intercontinental ballistic missile program.
- **$18.6 million USAF contract** for development and production of the intelligence data handling system for the WS-117L military reconnaissance satellite program. Lockheed Aircraft Corp. is the weapon system contractor.

Manufacturers also have "a natural reluctance" to make information available to STL that might lead to important patents, GAO said. The agency also reported that Ramo-Wooldridge and STL obtained title to "many valuable inventions" developed under Air Force ballistic missile contracts. Space Technology Laboratories has "objected strenuously" to the provision in contracts of National Aeronautics and Space Administration which vests patent rights with the government.

GAO declared that "the extraordinary increase" in the value of stockholdings of the officers, directors and key employes of Ramo-Wooldridge at the time of the merger with Thompson Products "indicates the value of the knowledge and capability it had acquired" as technical director of Air Force's ballistic missile program. Class B common stock offered key personnel under an option for $2 a share in 1953-55 increased in value to $831 a share at the time of the merger in November, 1958. The 18,790 shares purchased a few years previously for $37,580 had a value of $15.6 million.

GAO also reported on what it termed the "phenomenal growth" of Ramo-Wooldridge during its association with the ballistic missile program:

- **Total assets increased** from $247,848 at the time of its establishment in December, 1953, to $39 million in October, 1958, prior to merger with Thompson Products, plus investments in, and advances to, subsidiaries of $2.7 million.

• **Sales increased** from $2.2 million for 1954, the first full year of operation, to approximately $50 million for the first 10 months of 1958.

• **Sales from inception** of the company through October, 1958, amounted to over $134 million, exclusive of subsidiaries. Net income of Ramo-Wooldridge for this period amounted to $6.7 million before taxes and exclusive of subsidiaries.

• **Ramo-Wooldridge grew** from three employes in September, 1953, to 4,384 in October, 1958. Personnel directly involved in the ballistic missile program increased from 170 in December, 1954, to 2,770 in October, 1958.

The General Accounting Office began its investigation of Air Force management of its ballistic missile programs a year and a half ago, after it said USAF refused to make available the complete report of its Inspector General on the programs (AW Nov. 17, 1958, p. 34).

During its investigation, GAO complained that USAF continued to deny it access to key reports and documents, not on "security" grounds, but because Air Force said they were "privileged." Records that were given to its staff, GAO said, had been screened, and "it was evident that information of a critical nature had been withheld. . . . Project officers were instructed that they were not expected to volunteer information to us."

An Air Force report evaluating all Thor intermediate range ballistic missile launchings through 1958 was revised after it was reviewed by GAO and "statements which reflected unfavorably on the program were modified," the agency said. GAO said it also had been denied reports based upon a USAF management survey of the Convair Astronautics Division of General Dynamics Corp., which was made in November, 1956, and a management survey of the Martin Co., made in December, 1959.

House, Senate Conferees Boost NASA Budget by $55 Million

Washington—House and Senate last week approved a joint conference committee report which boosted the National Aeronautics and Space Administration Fiscal 1961 budget authorization to $970 million—$55 million more than requested.

Action was taken to permit a quick request for additional funds to the $55 million limit in the event of technological breakthroughs or a needed acceleration in any of the programs without first asking Congress for prior authorization.

It followed a warning by NASA Administrator T. Keith Glennan that "we have grave doubts about our abilities to maintain our presently-scheduled activities and flight schedules with the funds estimated."

At the same time, both houses approved a conference recommendation to accept a House amendment authorizing NASA to establish a total of 290 positions outside Civil Service pay scales, 30 more than now. This permits NASA a total of 13 positions in the $19,000 to $21,000 salary range; the remainder of the 290 would be in the $14,000 to $19,000 range.

The House first authorized an additional $5 million for emergency construction and equipment beyond the $915 million total requested by the Administration. The Senate later added another $50 million authorization for emergency research and development. The House, however, initially cut $38.9 million from the $915 million in actual appropriations.

Conferees said they agreed to the Senate amendment of $50 million in order to be sure that neither the space program nor the safety of personnel are jeopardized by lack of funds.

Soviet Rocket Chief

Soviet Union's separate missile command (AW May 16, p. 27) will be headed by Marshal Mitrofan Ivanovich Nedelin. He formerly headed the Soviet army artillery and for the past 10 years has been chief of the principal artillery administration in the USSR Ministry of Defense.

"It seems apparent that the NASA has made little or no provision in its 1961 estimates for contingencies, cost increases or unplanned program modification," the report said. "Oftentimes, necessary changes in order to ensure safety of personnel and system reliability such as the Project Mercury program cannot be accomplished by reprogramming alone without adverse effects on other important elements of the space program. Furthermore, information has been received that several of NASA's programs have increased in cost over original budget estimates."

Rising Costs

The report said current estimates for Fiscal 1961 already exceed the original budget estimates by $20.5 million. This includes a $14.6 million increase in the Atlas-Agena procurement program, a $300,000 increase in the Thor-Agena procurement program and, according to Glennan, a $1.5 million increase from a final decision to utilize the Centaur stage in the Saturn program.

Other examples of cost overrunning original estimates were given to the Senate Appropriations Subcommittee on Independent Offices, when Glennan appeared to seek restoration of $38.9 million the House cut from the Fiscal 1961 budget.

He said:

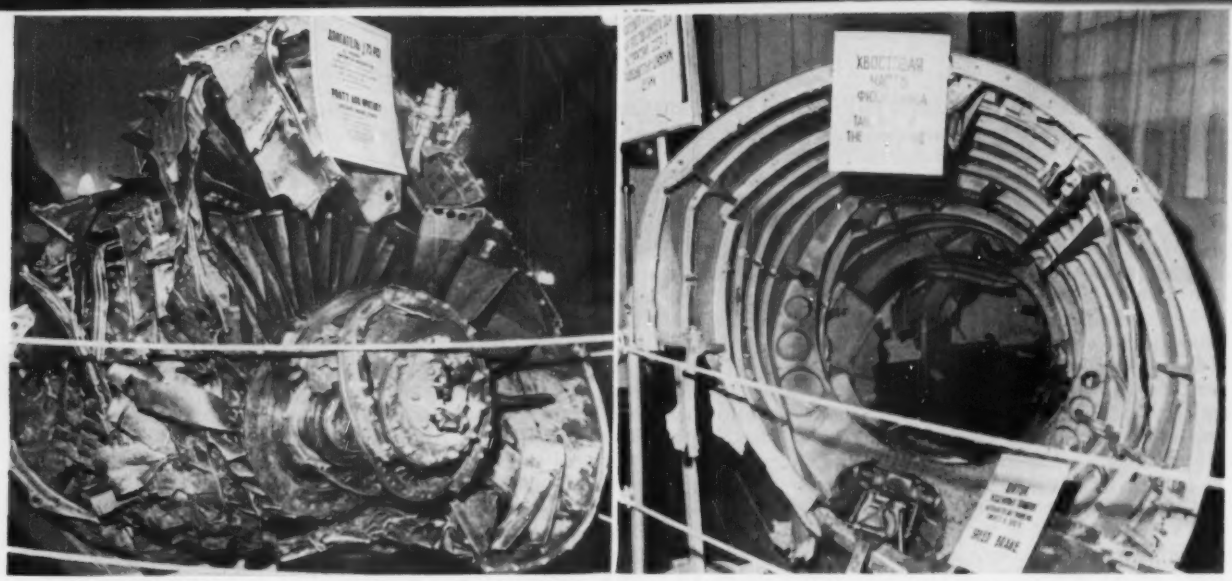
"In fiscal year 1960 for instance, there have been major overruns on Tiros I and its booster, on the development of the Nuclear Emulsion Recovery Capsule (NERV), and on the Pioneer V and the Explorer satellites. . . . We also must be able to find an additional $5.5 million for vehicles for our 1960 lunar exploration program."

Why Overruns

The most important reason that costs outrun estimates in research and development, he explained, is that it "takes us into the unknown where precise estimates are difficult—in fact, impossible to achieve in many areas." He added:

"Programs are changed to meet new developments, unforeseen difficulties occur, accelerations of activities take place to meet new schedules, cost increases are confronted—these are the day-to-day realities of the research and development business. . . . I can assure you that NASA has no cushion to absorb either cost increases which already face us or reductions in the funds voted by the House."

Glennan said the unforeseen cost increases have had to be covered at the expense of other programs since no contingency funds were provided. Some of these programs have been reduced in scope, others deferred as "we robbed them to get on with the more immediate tasks."



COMPRESSOR SECTION (right) of the Pratt & Whitney J75-P-13 turbojet shown in Moscow's Gorki Park by the Soviets as part of the wreckage of the Lockheed U-2 lost near Sverdlovsk apparently has a larger inlet area than those normally used on military and civil versions of the engine. Compressor blades visible in the wreckage also appear to have longer chords than those on mass-produced versions. Altitude performance of the original J75 could be improved by increasing its inlet area to provide a larger airflow and by increasing the chord of its compressor blades to achieve a more efficient pumping action on the low density air above 70,000 ft. Casing around the compressor section was broken loose in the U-2 crash, and many of the exposed blades were bent backwards rather than shearing off, indicating that the engine was not running when the aircraft struck the ground. Condition of the blades at the bottom of the engine also was an indication that U-2 pilot Francis G. Powers made an emergency belly landing. Pratt & Whitney construction practice in recent years has been to use titanium for most of the blading and parts of the compressor sections of the J75 and other engines. Extremely light construction of the U-2 is shown in photo at left of the inside of the tail section of the aircraft. Small ring frames to keep the light gage skin from buckling are visible. The only heavy frame is used as an attachment point for tail wheel fitting at bottom of picture.

U-2 Carried Inertial Guidance System

Washington—Lockheed U-2 downed near Sverdlovsk (AW May 16, p. 26) carried a Massachusetts Institute of Technology inertial guidance system that permitted it to navigate accurately without relying upon external radio-navigation aids.

Inertial guidance system carried in some models of the U-2 was developed at the MIT instrumentation laboratory several years ago as a state-of-the-art project.

Technical analysis of new pictures obtained from Moscow tend to confirm earlier information that the U-2 made a controlled emergency landing (AW May 23, p. 34); that it was not severely damaged at high altitude by a "rocket" as claimed by Soviet Premier Nikita Khrushchev. Details tending to confirm that the aircraft made a belly landing include:

Damage to the J75 engine compressor section was confined to the underside; fuselage damage was severe along its bottom but relatively light on the upper surfaces; wings were sheared cleanly from the fuselage and suffered moderate other damage, with the slipper tanks on their leading edge almost intact, still in place and damaged largely on their underside; empennage damage appeared to stem from scraping along its bottom after impact with the ground.

While President Eisenhower canceled U-2 operations over the Soviet Union before the summit conference, the future is uncertain for U-2 operations in areas outside the Western Hemisphere.

The three Air Force provisional weather reconnaissance squadrons which provided logistical support in these areas for the weather research program of National Aeronautics and Space Administration are still in existence, but operations apparently have been halted.

Normal USAF operations with the U-2 by other units are continuing within the Western Hemisphere. These include radiation measurements in South America and meteorological and infrared research over the U.S.

The three USAF squadrons used to support NASA research operations are ostensibly in charge of U-2 strategic reconnaissance operations, although their aircraft are not owned by the Air Force and their pilots and maintenance personnel are working under contract to civilian firms and taking orders primarily from the Central Intelligence Agency.

These three weather reconnaissance squadrons and their bases are:

- **Atsugi Air Base**, Tokyo, Japan: Weather Reconnaissance Squadron, Provisional (1st).
- **Incirlik Air Base**, Adana, Turkey: Weather Reconnaissance Squadron, Provisional (2nd).
- **Edwards AFB**, Calif.: Weather Reconnaissance Squadron, Provisional (3rd).

Weather reconnaissance flights in the name of NASA apparently have been discontinued since the U-2 was lost over Sverdlovsk.

Normal Air Force flight operations with the U-2, in which the pilots and all personnel are members of the service, have been confined to the Western Hemisphere, and they are continuing.

Three Strategic Air Command U-2s are now flying from Ezeiza International Airport near Buenos Aires, Argentina, on a three-week program as part of Operation Crowfoot to measure the amount of radiation in the upper atmosphere below the equator.

This short flight program is intended to bring up to date data obtained in a USAF-Atomic Energy Commission-Argentine government research program conducted from the fall of 1958 to August, 1959. Laughlin AFB, Del Rio, Tex., is the training and permanent base for SAC U-2s.

Air Research and Development Command flies U-2 aircraft from Edwards AFB, Calif., for two main purposes:

- **Support for the Midas** early warning satellite program through infrared measurements made at high altitude during the boost phase of ICBM flights.
- **Upper air meteorological** research.

Congress Probes Summit Meeting Issues

Washington—Congressional inquiry into the U-2 incident and other circumstances surrounding the collapse of the Paris summit conference got under way on several fronts last week.

Aside from the partisan debate on issues involved, these developments unfolded:

• **Sen. J. William Fulbright** (D.-Ark.), chairman of the Senate Foreign Relations Committee, began what he termed "an objective and impartial" investigation of events and policies which led to the summit failure.

• **Sen. Richard B. Russell** (D.-Ga.), chairman of the Senate Armed Services Committee, announced that its subcommittee on the Central Intelligence Agency will investigate the U-2 incident in cooperation with the Appropriations Committee.

• **Sen. Henry M. Jackson** (D.-Wash.), chairman of the Senate Subcommittee on National Policy Machinery, opened a "non-partisan series of hearings" focused upon the National Security Council and the problem of coordination between the Departments of State and Defense.

• **Sen. Stuart Symington** (D.-Mo.), a member of the Senate Armed Services Committee, urged Congress to appropriate $3.5 billion above the amount requested for defense by the Administration for Fiscal 1961 to strengthen national defense "in view of the threat facing the free world."

• **House Foreign Affairs Committee** headed by Rep. Thomas E. Morgan (D.-Pa.) was briefed on the Paris development by Secretary of State Christian Herter.

In addition to the announced hearings on the U-2 incident and the summit, it is likely that the National Aeronautics and Space Administration will be asked searching questions regarding its connection with the U-2 incident and the possible impact it will have on future relations with foreign governments if NASA appears before the Senate Space Committee to support proposed changes in the Space Act of 1958. The House Space Committee has concluded its hearings and reported the bill out. Action is pending on the House floor.

In another move, Rep. Cornelius E. Gallagher (D.-N. J.), who previously released a list of what he said were 100 Soviet spies caught since 1946, called upon Secretary Herter to prepare a "bill of particulars" on all Soviet espionage activities to counteract Soviet U-2 "spy" charges now being aired in the United Nations.

SEVEN WINDOWS for reconnaissance cameras were secured in the bottom of the Lockheed U-2 downed at Sverdlovsk in the single frame shown above. One of the aircraft's cameras and its shattered lens are at right.

CONDITION of the U-2 tail section indicates that the forces which damaged it were primarily applied along its bottom during landing. Lower portions and most of the frames are broken and sheared away while their top sections are still attached to the large stringer at top of the fuselage. Relatively wide spacing of the lightweight wing stringers in picture of U-2's wing root at right is an indication of the U-2's low design loads. Slipper tank on the leading edge of the wing is in the center of the photo.

Neutralist Nations Keep Sharp Watch on UN Debate on U-2

New York—Taking shape behind the opening United Nations debate last week on the U-2 incident was the possibility that friendly nations would tighten controls on U.S. military aircraft operating within their borders.

Delegates of countries not directly concerned were watching intently for signs that Pakistan, Norway and Turkey—and possibly other states linked by treaty to the Western alliance—intended to restrict U.S. aircraft movement following new Russian demands before the UN Security Council.

During presentation of his draft resolution seeking condemnation of the United States for staging the U-2 flights, Soviet Foreign Minister Andrei Gromyko specifically warned Norway, Pakistan and Turkey that they were "accomplices and parties to aggression."

Noting that Norway and Pakistan had protested the use of their air bases in connection with the flight of the U-2, downed on May 1 while 1,400 mi. inside the USSR, Mr. Gromyko said:

". . . If the governments of these countries content themselves with just these protests and do not make any more serious and foregoing conclusions, they may find themselves even against their will in a position when the territories of their states may become a springboard for aggression and consequently the object of a retaliatory blow."

Although none of the threatened states are represented on the 11-nation council, their attitudes toward the Soviet warning may be voiced if the Soviet Union appeals an adverse decision of the Security Council to the UN's General Assembly.

Unofficially, a Pakistan government spokesman said here that new controls on U.S. Air Force flights from Pakistani airports would be a logical consequence of the U-2 incident to ensure against repetition.

Pakistan, however, has rejected a Soviet protest which charged that Pakistani officials had sanctioned the U-2 flight, officially stating only that it accepted President Eisenhower's assurances that such reconnaissance missions would be stopped as sufficient safeguard.

Gromyko's speech to the Security Council, which was somewhat more belligerent than Western delegates had expected, stressed the danger of an accidental war. Suppose, the Russian spokesman conjectured, that at the same time a U-2 was spotted on Soviet radar screens, other planes participating in NATO maneuvers in Western Europe also were picked up as targets.

". . . Who can deny that, given the deliberate violation of the Soviet border that had already taken place, the appearance . . . of such aircraft would provide the command of the Soviet armed forces . . . with all grounds to conclude that a military attack was being launched against our country, and to retaliate by an immediate counter-blow?" the foreign minister asked.

In a 19-min. rebuttal to the Soviet charges, Henry Cabot Lodge, U.S. ambassador to the UN, denied that aerial surveillance flights "continue to be the state policy of the United States."

He then cited the Soviets' refusal to accept President Eisenhower's open sky plan in 1955, their refusal to permit aerial inspection of the Arctic as recommended by the UN General Assembly and their refusal to consider "technical measures to prevent surprise attack," or controlled disarmament.

The Communists' paramount theme—that flights similar to the U-2 mission violated a nation's sovereignty and hence international law—was articulated by Jerry Michalowski, Polish delegate.

The principle that states have exclusive sovereignty over their airspaces, Michalowski said, was embodied in the Paris Convention of 1919, the Havana Convention of 1928, and also in Article 1 of the Convention on International Civil Aviation of 1944, from which he quoted:

"The contracting states recognize that every state has complete and exclusive sovereignty over the airspace above its territory."

Although the thorny question of sovereignty in the upper reaches of space above a given nation was ignored by Mr. Gromyko when he addressed the council on May 23, the following day it was declared irrelevant by Poland's UN delegate.

Great Britain, France, China and Italy, however, put forth the argument that the man-made satellites' disrespect for international boundaries rendered the Soviet U-2 complaint insignificant. The implied non-Communist position was that the flight of an aircraft over another nation without permission was no more in violation of international law than the comparable orbit of a space vehicle.

The absence of precedent with which the upper limit of airspace could be defined and related to national sovereignty seemed to foreshadow the future trend of UN space debate.

Mercury Booster Tested

First static firing of Redstone booster with boilerplate Mercury capsule attached lasted more than 100 sec. Test firing, at George C. Marshall Space Flight Center, Huntsville, Ala., indicated stresses to which capsule and pilot would be subjected on 200-mi. training flight.

Hurley Resigns From Curtiss-Wright

Roy T. Hurley retired last week as chairman, president and a director of the Curtiss-Wright Corp. as the culmination of a period of declining sales and earnings and a widening breach with other Curtiss-Wright directors.

T. Roland Berner, a New York lawyer, will become chairman. He is not expected to become permanent operating head of the company but to lead the search for new management for the corporation. In addition, an executive committee was formed of board members to include Berner, Levin H. Campbell, Jr., former Army chief of ordnance; James R. MacDonald, chairman and president of General Cable Corp.; Donald C. Power, chairman of General Telephone and Electronics Corp., and Lloyd H. Smith, an independent oil and gas operator.

The retirement came as no surprise to New York financial sources. They noted that Hurley had tended to play a one-man role in the company, speaking unilaterally for the board, and that the board had been embarrassed by this and incidents such as the announcement of licensing of the German NSU rotary engine last year just prior to a dividend cut. The Securities and Exchange Commission investigated the latter incident, but no action has been taken.

Wall Street viewed merger as one possible route that might be taken to bring in new management. Berner is a director of two companies created by consolidations—General Precision and Amerace. Though earnings declined to $14 million last year from $25 million the year before, Curtiss-Wright has approximately $195 million in capital and earned surplus, which could be a strong asset either in merger efforts or in company-sponsored development programs new management might emphasize.

Hurley plans to devote his entire efforts to development of new products, but this was not elaborated. Under terms of Hurley's contract cited in the company's latest proxy statement (AW Apr. 25, p. 30), he or his estate is to be paid $50,000 annually for 10 years after termination of his employment with the company.

Soviet Sputnik IV Re-Entry Try Fails

By Craig Lewis

Washington—Soviet attempts to re-enter the cabin section of Sputnik IV have backfired, sending the satellite into a wider orbit and separating it into several pieces.

Soviet plans to separate the cabin from the satellite instrument section (AW May 23, p. 27) and bring it back into the atmosphere failed when the retrorocket fired in the wrong direction. At the same time, the satellite exploded or was separated into a number of sections, all of which went into a new orbit with a longer life expectancy than the original one. Sputnik IV was still broadcasting late last week.

National Space Surveillance Control Center reported last week that the satellite is now in an orbit with a perigee of 189 stat. mi., an apogee of 412 mi. and a period of 94.3 min. Last stage rocket case remains in the original satellite orbit with an apogee of 222 mi., a perigee of 189 mi. and a period of 91.1 min.

Both orbits are in approximately the same plane.

As Sputnik IV moved around its new orbit, the center reported that several pieces began to appear as separate objects. Last week, seven new pieces had been identified in addition to the main satellite body, and it required 16 min. for all the objects to pass a given point in the orbit. These pieces were in the same orbit as Sputnik IV or in orbits only a mile or so smaller. More pieces may be distinguished as time passes.

At about the same time the Sputnik IV re-entry effort failed, the surveillance center estimates that Lunik III, the Soviet lunar probe that photographed the far side of the moon, re-entered the atmosphere and burned.

Describing the Sputnik IV incident, Tass, the Russian news agency, reported that on May 19, four days after launch, "the order was sent to the ship to switch on its braking device in order to deflect the ship down from its orbit and detach the pressurized cabin. However, as a result of a fault which had developed by that time in one of the instruments in the space ship's orientation system, the direction of the retrorocket's blast deviated from that planned.

"As a result, the speed of the space ship, instead of being reduced, increased slightly and the ship slipped into a new elliptical orbit, lying almost in the same plane but having a much higher apogee."

The 10,000 lb. Soviet satellite included an instrument section containing 3,250 lb. of instrumentation plus chemical and solar batteries, and a hermetically-sealed cabin weighing about 5,512 lb. The cabin had a controlled environment similar to that needed to support human life in space, and it carried the weight equivalent of a human passenger. It was instrumented to telemeter data on its internal environment during its flight and re-entry.

Tass reported that before the re-entry attempt was made, the cabin had completed its program of observations and that telemetered data indicated "the system of conditioning and heat regulation systems of the ship functioned normally throughout the entire flight and ensured conditions necessary for future manned flights."

After it separated from the instrument section, the space cabin was to have telemetered data during re-entry. Soviet scientists said they expected both sections to burn in the atmosphere and had no plans to recover them. Instead, the sections of the spaceship have gone into a new, wider orbit.

Soviet scientists have stressed the importance of the two-way communications test they say they have conducted with Sputnik IV. They said that a dual control system will have to be used in future manned space vehicles so the vehicle can be controlled both by its pilot and by ground stations.

Soviet scientist N. Varvarov suggested that a satellite orientation system based on cosmic ray sensors might be used in Soviet space vehicles. Writing in Komsomolskaya Pravda, Varvarov pointed out that strict orientation and stabilization of a vehicle in a fixed orbit improves scientific data. He also observed that continuous orientation of a spaceship and stabilization of its position in space is an infinitely more complex task than the partial orientation required in photographing the moon with Lunik III.

Varvarov said this orientation can be achieved two ways—using cosmic rays or the force of earth's gravity. With a cosmic ray system, several counters would be installed in a space vehicle, oriented along a line horizontal to the earth. If the vehicle deviated from its desired attitude, according to Varvarov, the number of cosmic ray particles counted would vary and signal the stabilization system to make corrections. On the alternate gravity orientation system, he said only that it would work in a way similar to the cosmic ray system.

Relay Repeater Satellite

Project Advent or Comsat, aimed at putting a 24-hr. relay repeater satellite in an equatorial orbit, has been slowed from its originally projected crash program (June 29, 1959, p. 18), to that of a normal research and development effort, with initial launch within the next two years. The Advanced Research Projects Agency-sponsored project is emphasizing reliability, because it will involve relatively few test firings. Launch vehicle is the Centaur.

Comsat is considered quite complicated—even more so than some of the ballistic missile systems.

Launch from Cape Canaveral, Fla., will endeavor to put the vehicle into a parking orbit, then progress to a transfer orbit for altitude, with the trajectory turning as it crosses the equator, to parallel it.

Air Force's Ballistic Missile Division has project management, with Army Signal Corps Research & Development Laboratory responsible for the development of communication equipment. Space Technology Laboratories is performing systems engineering and technical direction for all of the subsystems except the communications system, for which it has systems engineering and technical direction for integration only.

NASA Stops Operating Pioneer 150 Watt Unit

Washington—National Aeronautics and Space Administration has suspended operations with the 150-watt transmitter in Pioneer V and will not be able to transmit data over the ranges up to 50 million mi. once expected.

Batteries in the space probe apparently have deteriorated (AW May 16, p. 34), and the power drain of the 150-watt transmitter is too great for them. Transmission is automatically cut off when power supply drops below 15 volts, and this automatic system was shutting the transmitter down almost immediately when the last attempts were made to get data on May 21. Apparently, the power used in commanding the transmitter to switch on exhausted the available supply.

Late last week, NASA was still receiving 30-40 min. of data a day from the Pioneer V five-watt transmitter through the 250 ft. radiotelescope at Jodrell Bank, Manchester, England. This data was received at the rate of one bit per second and should continue to be received until the probe is about 20 million mi. from earth, although the quality of the data over these distances will be poor. The probe's five-watt unit is beyond the range of the 60 ft. antenna at South Point, Hawaii.

U.S., French Teams Win NATO's Aerial Reconnaissance Exercise

By David A. Anderton

Bremgarten, Germany—U. S. Air Force and French air force teams of the Fourth Allied Tactical Air Force racked up top scores to win Royal Flush Five, NATO's prime aerial reconnaissance exercise organized by Allied Air Forces Central Europe (Aircent).

Top scoring team in the daylight events was a French air force unit flying Republic RF-84Fs on short-range missions. Night reconnaissance missions were won by teams from USAF's 10th Tactical Reconnaissance Wing flying Douglas RB-66 aircraft.

Winning ATAF teams ran up a total of 20,851 out of a possible 21,560 points. Point spread between Fourth and Second ATAF was only about 4% on totals, emphasizing the over-all evenness of the contest.

Royal Flush exercises—this year's is the fifth—grew out of a standardization program developed by Aircent to improve its reconnaissance capability. The competition was added to the program as an incentive; Royal Flush One was held in 1956 and the Gruenther trophy, donated by Republic Aviation Corp., was first won by Fourth ATAF. Following three Royal Flush exercises were swept by Second ATAF, spearheaded by top teams of the Royal Air Force.

Four types of missions were planned for the competition: short range, of 260 naut. mi. total track distance, medium-range, of 350 naut. mi. and two long-range missions, both of 900 naut. mi. total distance, one in daylight and one at night.

Short-range mission was won by the French, flying against Royal Air Force Vickers Supermarine Swift FR-5s from Second ATAF. French RF-84F teams also took one group of medium-range events from the Belgian outfits of Second ATAF, also flying Thunderflash aircraft.

Other medium-range contest was won by Dutch pilots flying Republic RF-84Fs in competition with McDonnell RF-101C aircraft of USAF's 66th Tactical Reconnaissance Wing. The 66th lost a close one to RAF Canberra PR-7 units on long-range missions.

Night event—included this year for the first time—was taken by USAF's 10th Tactical Reconnaissance Wing flying against RAF Canberra PR-7 aircraft, generally favored to win the event.

Competition was planned to simulate field operations as much as possible, although local air traffic and control problems did not permit rapid scrambling of the missions. Timing began when judges handed sealed mission envelopes to the teams; the envelopes contained a standardized form giving the mission and target coordinates. Pilots had a maximum of 40 min. to plan the mission and get the engines started for takeoff.

Timing stopped with engine start, and began again when the pilot started his takeoff roll. On returning from the sortie, the pilots were instructed to report in 1 min. out and from 1,500 ft. This alerted the timers, who stopped the watches when the pilot made a low pass or a radar check over the field before entering the pattern.

Flight plans had to be accurate within one minute of estimated time. No land-based navigational aids could be used and instruments were sealed off by the umpires. Targets were generally identified only vaguely by description, although accurately by coordinates and pilots had to take photos and make visual observations to get maximum point scores.

Limits on altitudes were set at 2,000 ft. en route and 500 ft. over the target, and minimum speed was held to 300 kt. Only one pass over the target was allowed.

Two types of intelligence reports were scored: hot reports, which were transmitted electrically to judges by photo-interpreters working from wet negatives, and immediate reports, which were the "second look" type, a detailed report accompanied by marked photographs. Hot reports generally included information of immediate value for a tactical strike, such as size of airfields, numbers of targets or their disposition. Immediate reports are much more detailed and include information useful for battle strategy.

Midas Tests Detection System

Washington — Air Force-Lockheed Midas II satellite last week was successfully returning infrared surveillance information from a near circular orbit, providing the first test of a system that eventually should give the nation 30 min. warning in case of an enemy ballistic missile attack. Current theoretical warning time is about 15 min.

The 5,000-lb. satellite, heaviest to be put into orbit by the U. S. except for the 8,600-lb. Atlas tank orbited Dec. 17, 1958, in Project Score, is expected to return infrared data for three to four weeks and stay in orbit for approximately three years.

It will attempt to monitor missile launchings from the Air Force Missile Test Center in Florida and Vandenberg AFB in California. USAF also planned to set off a 45-sec. flare, visible for 50 mi., at Edwards AFB, Calif., early today and others at Vandenberg tomorrow and Wednesday if the weather remained clear.

Midas II was launched at 12:37 p.m. EST May 24 from Cape Canaveral, Fla., by USAF-Convair Atlas 45-D. Refined orbital data six hours later placed the apogee at 322 mi., perigee at 292.1 mi. and orbital period at 94.3 min. Inclination of the orbit to the equator was about 28 deg., which gave the satellite a path that would not carry it over the Soviet Union.

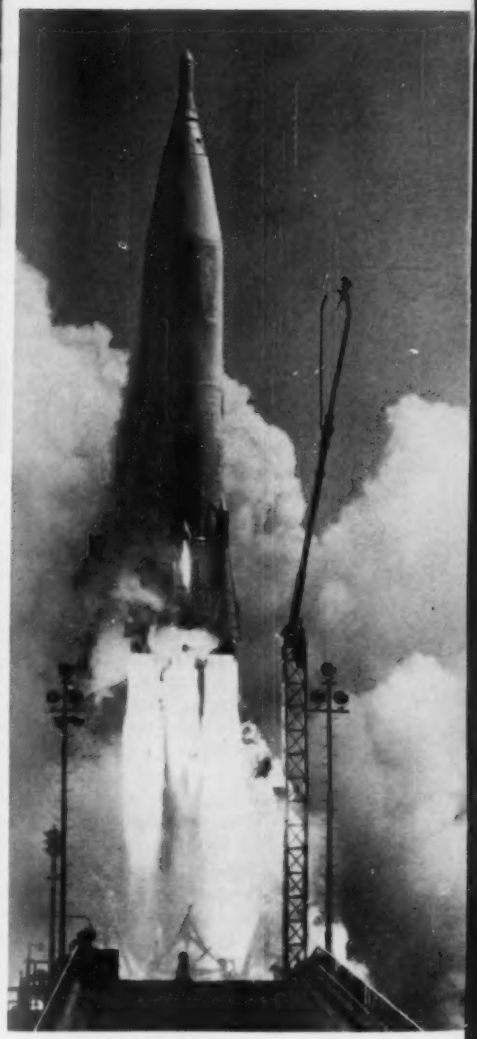
Atlas boosted the satellite, which consists of the entire 22-ft.-long Lockheed Agena second stage, into a predetermined "staging box" in space before it was separated by explosive bolts, retrorockets and separation squibs. The satellite then coasted prior to the firing of the Bell Hustler 15,000 lb. thrust engine. As it coasted, it positioned itself horizontally to the earth.

Programmer ignited the Hustler engine to increase velocity and inject the satellite into orbit. During injection, pitch and yaw were controlled by gimbaling and roll by gas jets. Engine was shut down after an integrating accelerometer determined that the desired velocity had been reached.

Shortly after shutdown, the attitude control system positioned the satellite in a nose-down position, placing its infrared eye toward the earth. The satellite will remain earth-oriented.

Payload package, which is about 5 ft. in diameter, weighs approximately 5,000 lb. after burnout of the engine. Payload includes the infrared equipment and its electronics, a data link telemetry system, ground-space communications equipment and engineering telemetry to monitor operation of the satellite systems and infrared experiment.

Tracking and data readouts are obtained by USAF-Lockheed satellite tracking stations at Vandenberg AFB and Kaena Point, Oahu, Hawaii, and transmitted instantaneously to the Air Force Satellite Test Center at Sunnyvale, Calif., which handles over-all control of systems operation (see p. 57). Data from the scanner also can be read out at Cape Canaveral and at downrange stations of the Atlantic Missile Range. First attempt to launch Midas, which is being developed by Lockheed for Air Research and Development Command's Ballistic Missile Division, failed last Feb. 25 because of a malfunction during Agena separation.



Atlas Uses Modified Nose Cone on Indian Ocean Shot

Standard USAF-Convair Atlas-D model (56-D) carrying a new modification of the General Electric Mark 3 nose cone flew some 9,040 mi. from Cape Canaveral, Fla., into the Indian Ocean on May 20. Missile was not hot-rodded in any way, had fuel left that could have increased range slightly. Weight was a little higher than normal because missile carried instrumentation to monitor a trouble area that developed in recent D-model firings. Precautions taken to safeguard against this trouble also increased weight slightly. Modification 2 of the Mark 3 cone made its first flight. Aft section of the cone now is bi-conic to increase performance on re-entry. Longer range and slightly steeper re-entry angle meant the cone experienced high Mach numbers and therefore greater heating than it would on re-entry on a 6,300 mi. shot, but the Mark 3, Mod. 1 could have accomplished this re-entry also. Accuracy of the shot, which was aimed at 38 deg. south latitude and 38 deg. east longitude, 1,000 mi. southeast of Capetown, South Africa, was very good. D-model is capable of even greater range when fired in an easterly direction, carrying this nose cone (AW Mar. 21, p. 34). This was the 51st Atlas launched and the longest range known to have been achieved by any intercontinental missile. Flight time was 52.5 min.

News Digest

Legislation that would ban incentive payments on defense contracts unless the manufacturer can "completely demonstrate" that he has earned them has been introduced by Rep. Carl Vinson (D.-Ga.), chairman of the House Armed Services Committee. Hearings are scheduled to begin this week. The measure, also aimed at increasing the use of advertised bid contracting and increasing competition in negotiated contracting, was drafted by the General Accounting Office at Vinson's request (AW May 16, p. 125).

Henry J. E. Reid, 64, has relinquished directorship of National Aeronautics and Space Administration's Langley Research Center in anticipation of retirement. He will continue to serve as senior staff adviser to Floyd L. Thompson, who moves up from associate director. Reid has been with NASA and the predecessor National Advisory Committee for Aeronautics since 1921 and was director for 34 years. Thompson joined NACA in 1926, became research chief at Langley in 1945, associate director in 1952.

Last early test model of Nike Zeus was launched last week from White Sands Missile Range. Army said this was the fifth completely successful firing.

CAB Suspends Proposed Rate Increases

Board action halts filing of widely-varied fares; order implies levels suggested so far are too high.

By L. L. Doty

Washington—Civil Aeronautics Board issued a tariff suspension order last week and brought to a halt a confused flurry of widely-different fare increases filed by trunklines in response to an earlier Board announcement that vaguely hinted it was ready to consider rate boosts.

The announcement gave no clue as to the level of rate hikes the Board would accept other than to state that the fair over-all rate of return for the trunkline industry has been set at "approximately 10.5%" (AW May 9, p. 46). By the middle of late last week, the obscurely worded announcement had evoked eight different interpretations from the 12 trunklines in filings for rate increases ranging from $1 per ticket to 10% across-the-board above current fares.

The Board's latest order suspends the first four of these tariffs to be filed but gave assurances that a decision on a fare level will be announced promptly. It implied, however, that the proposed fares filed at the time the order was issued were significantly higher than the rate level the Board had in mind.

As of late last week, most observers felt that a Board announcement finally setting a fare level was imminent but were concerned that any increase established would fall far short of industry requirements. In its order suspending the tariffs, the Board warned that ". . . no inference should be drawn . . . as to whether the Board will or will not permit a further general increase in fares at this time."

The suspension order by the Board was not unexpected. Tariff filings were an inevitable result of the announcement, and a broad range of proposed rate increases by the airlines was expected because antitrust laws prohibit carriers from collaborating with one another in working out tariffs. And, the Board was forced to suspend such tariffs since it logically could not approve a different set of rates for airlines competing with one another on identical routes.

Unknown Factor

Unknown factor is why the Board decided against setting a level for fares when the announcement was originally made, which reportedly was done without the unanimous support of the Board members.

The announcement of a fare increase in February, 1958, established standards which permitted all carriers to file for the same fare increase within 48 hr. after the release was issued.

Because the latest announcement, made on Apr. 29, failed to establish a rate level, a final decision on such a level already has been delayed four more weeks in a case that has run four years and a full year since the examiner's initial decision was issued (AW June 1, 1959, p. 38).

According to its order, the Board will review the proposals of all carriers and will then announce the tariffs that it will permit to become effective after June 30, the date current fares expire. The order also said it will institute an investigation to "determine and prescribe the lawful fares and provisions" of such fares.

Of the tariffs filed, four carriers—Capital, United, Northwest and Western—filed for a 4% increase plus an additional $1 on each ticket. American filed for an increase of 4% on all fares plus $1 per ticket except where existing first-class fares are now more than one-third greater than coach fares.

Eastern and National filed for a 5% increase plus $1 per ticket. Delta proposed only a $1 per ticket increase, and Continental asked for a straight across-the-board 6% hike. Braniff filed for a 5½% boost, Northeast for a 5% increase plus $2 per ticket. Trans World Airlines asked for a 10% increase.

What Airlines Want

For more than two years, airlines have been calling for a fare increase that would give them what they believe to be an adequate rate of return on investment and permit them to underwrite the some $3 billion turbine equipment program now well under way. To support its filing, American Airlines submitted a letter to the Board in which it noted that the 5.2% rate of return the trunklines averaged between 1957 and 1959 was only slightly above the 5% interest rate American was paying on its long-term loans covering the purchase of jet equipment.

American emphasized that airlines have been operating in recent years far below the 10.5% "over-all fair rate of return which the Board has now found they must be given the opportunity to earn." The airline noted that application of the fare increase proposed by American—4% plus $1 on each ticket—would add some $48 million to industry earnings, or a 9.7% rate of return on investment.

American, although predicting a marked improvement in earnings for the industry in 1960 despite a dismal first quarter (AW May 2, p. 26), forecast a $58 million net profit for the combined 12 trunklines for 1960 as compared with a $65 million net profit after taxes last year. The airline then noted:

"After payment of some $40 million for interest on debt, only $18 million would be left for equity holders, who had an investment of $670 million in the business at the end of 1959. Even assuming no increase in the net investment rate base over its amount at the end of 1959 . . . for 1960 the rate of return on investment would amount

PanAm, Austrian Pact

New York—Pan American World Airways has entered into an agreement with Austrian Airlines whereby the American carrier will provide commercial, technical and operational advice and provide personnel to assist in operating the airline.

A draft agreement has been signed, but necessary approval of the Austrian Council of Ministers is still pending. It is, however, expected to be obtained shortly and Pan American personnel already are scheduled to report to Austria.

Austrian Airlines began scheduled operation in 1957, after considerable organizational difficulties. It has encountered financial troubles and recently received a second round of government backed stop-gap credit.

Pan American will not comment, but a stock arrangement is understood to be included in the deal. The Austrian carrier recently bought six Vickers Viscount 837 turboprops.

to only 4%." American pointed to depressed value of airline stocks as an indication that the financial community has become aware of the disappointing earnings of the airline industry. It stated that, as of May 10, common stocks of the domestic trunklines had dropped from 30%—United—to 65%—Capital—below their 1959 highs. Average decline for the industry on both American and New York Stock Exchange listings was 45%.

Most airline stock market prices had fallen below their book value, the airline found, and stocks of seven carriers —Capital, Continental, Delta, Eastern, National, Northwest and TWA—were discounted to sell 25% or more under book value.

The airline said in its letter that debt ratios of the trunk airlines have climbed sharply in recent years because of heavy borrowings covering the purchase of jet equipment. Ratio of long-term debt for the industry to total capital has increased from 28.3% at the end of 1955 to 52.1% in 1959 with, American said, "indications that it will rise still further by the end of 1960."

Additional Financing

American said additional financing by the industry will call for a material strengthening of the equity position of the airline industry but it doubted that this could be achieved in the face of securities that continued to sell at depressed prices.

American noted that the initial decision of the CAB examiner in the General Passenger Fare Investigation in May, 1959, recommended an immediate increase in passenger rates of $1 per ticket, with such further adjustments as proved necessary by experience. It said this decision was based upon a calculated average return of 8.6% during the five-year period, 1954-1958, and on a projected operating profit of $180 million for 1959.

Actual operating profit for 1959, American said, turned out to be only $59 million—$121 million less than forecast, or a 6% return on investment in 1959.

Delta 880 Accident

Washington—Delta Air Lines Convair 880 turbojet transport crashed on takeoff during a training flight at Atlanta last week, killing all four crew members aboard. As of late last week, neither the airline nor Federal Aviation Agency investigators had determined possible cause of the accident. With four of 10 880s on order on hand, Delta was forced to postpone an 880 flight scheduled for inauguration yesterday between Dallas and Atlanta until sometime next month.

'Bus-Type' Service Requested On New York-Washington Route

By Robert H. Cook

Washington—Allegheny Airlines is making a strong bid to provide the first "bus type" commuter service between New York and Washington as a logical expansion of its current no-reservation flights in the Philadelphia-Pittsburgh market area.

Need for the new, low-cost service was emphasized by the airline's attorneys last week in filings with the Civil Aeronautics Board which closely follow recommendations made earlier by CAB attorneys in the New York Short Haul Coach Investigation.

In a statement of tentative position, Board attorneys urged a new experimental "no frill" service at fares below present coach levels for the New York-Washington route. Noting that the Board is still gathering information on the available rail service between the two cities, the attorneys proposed that CAB begin an investigation of the economic need for the economy flights and determine if an airline should be certificated to provide the service. Hearings on the coach case, which began on May 2, have been recessed but are scheduled to resume on June 20.

First move by Allegheny to move its "no frill" service into the New York short-haul market has been to consolidate its request asking removal of a present nonstop restriction on the New York-Washington route with its application in coach service investigation.

In support of its proposal, Allegheny contends that, while trunk carriers now provide coach service over the 215-mi. route, they are generally opposed to special economy flights that might result in lower fares on the ground that they are economically unfeasible.

Noting that the New York-Washington market generates an average of 2,000 local passengers a day and provided the airlines with a total of almost 715,000 local passengers in 1958, Allegheny maintains that the trunk carriers cannot afford lower economy fares because they operate the route in the same manner they handle a long-haul segment, complete with reservations service and all customary ground handling services.

Ticket fares for Allegheny's 269-mi. Philadelphia-Pittsburgh flight are $20.85 first-class, only $13 for the no-reservation service, as compared with one-way rail coach fares of $15.79. Flight times are 1 hr. 6 min. for turboprop Convair 540s, 1 hr. 25 min. for the piston-engine 440, according to Allegheny. Comparative times for ground transportation are 7 hr. 3 min. by rail; 6 hr. 53 min. by auto and 6 hr. 10 min. by bus, Allegheny figures indicate.

Although Allegheny competes with Trans World Airlines over the route, commuter service has succeeded in generating a greater passenger volume for both carriers during the past six month period, the Allegheny filing said.

Figures submitted by the local-service airline to CAB show that, out of a total of 23,571 nonstop passengers carried on the route by Allegheny, 32% traveled on the new no-reservation service. Local traffic carried in the period also increased by 39% in the same six months for a combined total of 78,747 passengers carried by both airlines.

Opposed Service

Noting that, although TWA first opposed the service, Allegheny pointed out the trunk carrier inaugurated its own no-reservation plan after CAB approved the local-service carrier's plans. Rather than depressing the traffic volume, Allegheny said the new service boosted TWA's traffic share in the Philadelphia-Pittsburgh market from 106,291 passengers between October, 1958, and March, 1959, to a high of 108,122 for the six months during which both airlines have provided the low-cost service.

As of last week, Allegheny had carried 36,355 passengers on its present commuter service, with an over-all load factor in May exceeding 60% and one flight attaining 82%. Of the total passengers carried on the route since the new service began, 11,809 have used the no-reservation service, which represents a doubling of such passengers carried as compared with ticket sales of last October.

Monthly rate of no-reservations passengers by the airline is now beyond 7,000 a month on the route, and Allegheny expects this volume to climb to 10,000 by the end of this year.

Allegheny's annual report, which emphasized its new Boston-Washington route as one of the "richest, most productive testbeds for the concept." shows that the airline increased its commercial revenues by 21% in 1959 and earned a small profit of $16,264 out of total revenues of $11.3 million, including subsidy payments of $3.4 million. Expenses for the airline climbed $2 million last year. Increase was attributed to added costs in flying operations and maintenance.

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CAB Blames Truck Beam Crack For 707 Landing Gear Failure

Washington—In-flight loss of two wheels from the left main landing gear of a Pan American World Airways Boeing 707 turbojet transport on takeoff from New York International Airport last July 12 (AW July 20, 1959, p. 34) has been traced to a crack in the aircraft's forward truck beam assembly by Civil Aeronautics Board investigators.

An accident report by CAB last week said failure of Pan American mechanics to properly replace a bolt designed to limit the vertical oscillation of the landing gear truck beam during takeoff and landing caused the initial crack.

The Board report added that the metal failure was further hastened by unequal braking on the wheels during gear retraction.

At the same time, CAB upheld the actions of the Port of New York Authority and the New York fire and police departments in handling record crowds watching at the airport as the aircraft circled the airport burning off fuel.

Public broadcasts of the turbojet's plight, CAB said, produced a traffic jam that clogged all access roads to the airport, and Port Authority fire workers were forced to turn a hose on a crowd of approximately 600 curious spectators who milled around the aircraft after its successful landing.

Although the National Assn. of Broadcasters has agreed to make specific requests of their members that radio and television newscasts of emergencies try and avoid prompting anything that might hamper the authorities, Board members said they intend to study this problem further.

Retracing the four-hour emergency, CAB said the wheel loss was first reported at approximately 8:37 p.m. when an Idlewild controller reported witnessing the wheels drop from Pan American's Flight 102 which had just taken off for London with 102 passengers and a crew of 11 aboard. Advised of the incident, the aircraft circled the area at a low altitude for about one hour, during which time Port Authority personnel recovered the missing gear from shallow water in the bay at the end of the runway.

In answer to Capt. Edward F. Sommers request, the last 3,000 ft. of runway 13R was covered with foam in preparation for an emergency landing. During the time necessary for this task, the disabled aircraft continued to circle to burn off fuel as a means of reducing the fire hazard and attaining a lighter landing weight.

Following the completion of foaming operations at approximately 11:25 p.m., Capt. Sommers made his approach and touched down within the first 3,000 ft. of runway, with the right main gear. Spoilers were raised immediately on contact and, as the left gear and nose wheels made contact, full reverse thrust was applied, permitting the aircraft to remain on a straight course until the full weight settled on the left gear and the left strut began to drag on the runway, the accident report said. Application of the right brake held the transport on the runway, and it came to a stop approximately 1,200 ft. from the foamed area.

Examining the landing gear assembly, CAB noted that Pan American records showed that a "snubber" bolt failure on this aircraft had occurred five days earlier on a takeoff from Boston. Two days later in Paris, attachment bolts for this part sheared off and were replaced with temporary bolts. On completion of a continuing flight, it was found that the temporary bolts also had sheared off, and the snubber assembly was removed and the aircraft flown to Idlewild where the same snubber assembly was replaced.

Board members noted that the aircraft's landing gear design is such that it could only suffer this type of crack damage if the snubber unit is removed or broken from one of its fittings. In the case of Flight 102, the forward truck beam could have been damaged during the flight from Boston after the snubber failed or on the later flight when the unit was removed, the Board said.

Capital Executive Shifts Continue

Washington—Capital Airlines last week again realigned its management structure in another move toward launching a long-range program designed to strengthen its financial position so that it will eventually be attractive to merger considerations.

Under the revamped management, David H. Baker, president of Capital since 1957, remains in that position, but James B. Franklin resigns as senior vice president for operations and will return to active flight duty as captain. Earlier, Thomas D. Neelands, Jr., an investment banker, was named chairman of the board with full power to direct the airline's long-range financial policies (AW May 23, p. 38).

The latest management changes preceded by three days the deadline late last week when Capital was required to answer a foreclosure suit brought against it in a New York federal court by Vickers-Armstrongs (AW May 9, p. 39).

They also brought charges from the Capital Shareholders Assn., a stockholders protective group organized by employes of the airline, that the second management change is a "smoke screen" and "an effort to confuse the public and avoid the real issue—the board of directors." The group, headed by senior Capital pilot Charles E. Beatley, Jr., added: "There is a new chairman, but the full complement of old faces is still there."

The employe group plans to begin a common stock proxy solicitation this week calling for a special emergency meeting of all stockholders. At this time, the employes will present their own slate of directors which, they feel, will put the carrier back on sound operating and financial grounds.

Meanwhile, Capital last week asked Vickers-Armstrongs for a further delay in the foreclosure proceedings to give the revised management sufficient time to work out a plan which, the directors feel, will give the airline an opportunity to settle the $33 million account due British note-holders on the unpaid balance of loans covering the purchase of a fleet of 60 Viscount turboprop transports manufactured by Vickers-Armstrongs.

Here are the management changes which the carrier has made in the past two weeks:

- **Thomas D. Neelands** fills the post of board chairman left vacant when George R. Hann declined to stand for re-election. Remainder of the board remains the same. Arthur F. Kroeger was elected chairman of the executive committee, a position formerly held by Charles H. Murchison.
- **Marvin Whitlock** was named senior vice president for operations and maintenance to take over direction of all activities, previously shared with J. B. Franklin, in these two departments. He will be assisted by R. W. Hardesty—vice president for operations.
- **John H. Mahoney,** former vice president-marketing, was named vice president-corporate affairs. He replaces Hayes Dever who becomes vice president-public relations.
- **Read Chalfant,** former vice president-sales, was named vice president and assistant to the president. He will maintain liaison between all departments and the president's office. John B. Andersen will replace Chalfant as assistant vice president for sales. Andersen was former director of public relations for the company.

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Examiners Debate CAB Reorganization

By Robert H. Cook

Washington—Theoretical blueprints on means of streamlining Civil Aeronautics Board procedures are mounting in the wake of last year's criticism of the Board by former member Louis J. Hector (AW Sept. 21, p. 36).

Latest critique of the Hector recommendations, which were thoroughly denounced by CAB attorneys, was made by CAB Examiner Paul N. Pfeiffer.

While condemning the Hector proposal that CAB's major functions be transferred to other government agencies and courts as the "wrong way," Pfeiffer called for "more, rather than less" judicial action by the Board and suggested several means of shortening CAB's present procedures and accelerating its workload.

A cross section poll of the Board's 24 examiners by AVIATION WEEK failed to win unanimous support for Pfeiffer's ideas, although there was tacit agreement on many points of major importance. (Opinions of the five Board members on CAB reorganization needs were reported in an AVIATION WEEK survey in the May 2 issue, p. 38.)

Pointing out that his views are not intended to reflect those of the CAB or its staff, Pfeiffer suggested the following changes for streamlining and strengthening Board actions:

• **Planning functions** should be handled by an independent Office of Public Counsel with the sole purpose of representing the public interest rather than acting as a policy formulation bureau or economic adviser to the agency. This office, Pfeiffer said, should deal with all regulatory agencies and should have the right to appeal agency decisions when necessary.

Examiners questioned were evenly split on this issue, with those in favor feeling that the present bureau counsel function of the CAB was more active in the past when this duty was performed by a public counsel as part of the Board's General Counsel office. Those opposed said they did not believe such a change would offer any benefits from the present system under which the bureau counsel is a part of the Bureau of Air Operations.

• **Hearing processes,** particularly in complicated economic cases, can be expedited by having two, rather than one, pre-hearing conference in order to narrow the issues to be considered in the formal hearing. To further reduce the size of the record, Pfeiffer favors short opening and closing statements by attorneys as a substitute for testimony by policy witnesses who, he says, "almost without exception, give rise to voluminous, usually fruitless, cross examination." Such practice, he believes, would serve to state the theory of the case without creating an opportunity for cross examination. After the conclusion of the hearing, Pfeiffer says both parties could then submit proposed findings of fact with supporting briefs for adoption or rejection by the examiner as a means of expediting his preparation of an initial decision.

This particular proposal drew strong support from other Board examiners polled, who added that authority to hold two or more pre-conference hearings already is held by the examiners who make individual determinations on this matter. Many cases, one examiner contended, should not require a pre-hearing conference. He also called for elimination of "so-called" expert testimony in favor of the opening and closing statements suggested by Pfeiffer and said that witnesses too often state personal conclusions instead of the facts of position.

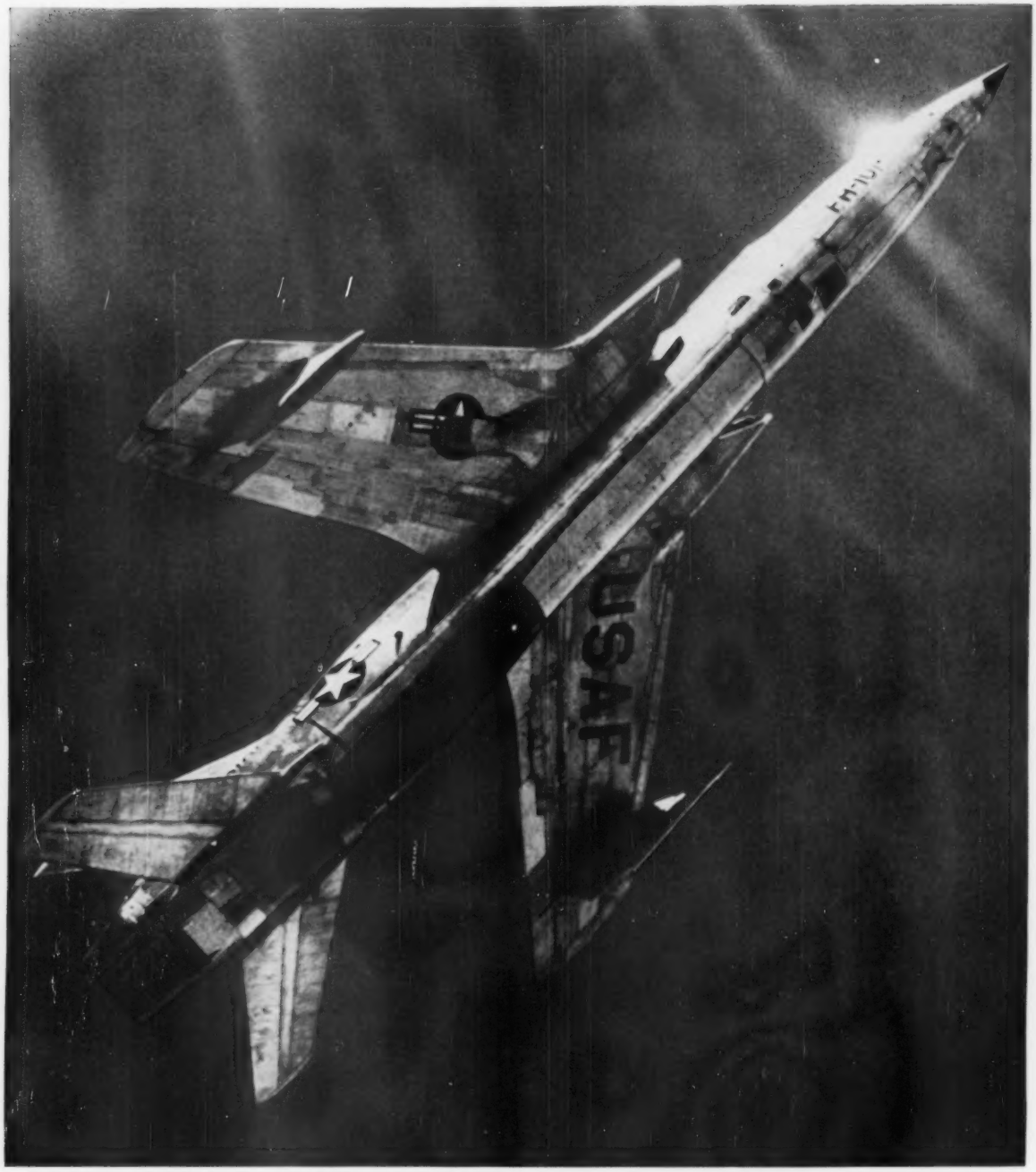
Another examiner, taking exception to the pre-hearing proposal, said that individual examiners often do eliminate policy witnesses when necessary and that one such conference is sufficient but that the time element needed to complete a hearing could be reduced by permitting the Board to issue a show cause order spelling out the geographical area to be considered in the entire case and the selection or carriers qualified to take part in the hearing. Issuance of such an order could be made by the Bureau of Air Operations, he said.

• **Examiners, properly equipped** and staffed, should be authorized to pass upon all interlocutory motions with such questions as who should be permitted to intervene in the case. Scope of the issues should be initially determined by the assigned examiner. Pfeiffer said that procedural steps in many cases are often postponed indefinitely because existing rules require Board members to pass on purely interlocutory matters.

On this question, other examiners had conflicting viewpoints, with those in agreement urging that they be "given more room for independent thought." One of the major hindrances cited to hearing progress was that examiners are

Helicopter Society Honors President Eisenhower

President Eisenhower was presented a plaque in recognition of his extensive use of helicopters by the American Helicopter Society at its annual meeting in Washington, D. C., shortly before the chief executive left for Paris and the summit crisis. Presenting the award are Ralph P. Alex, (center), outgoing president of AHS and chief of components design for Sikorsky Aircraft Division of United Aircraft Corp., and Charles H. Kaman, AHS awards chairman and president of Kaman Aircraft Corp. President of the society for the coming year is Lee S. Johnson, general manager of Sikorsky.



The Republic F-105D streaks to a new world speed record...

powered by a Pratt & Whitney Aircraft J-75 jet engine

On December 11, 1959, the Republic F-105D fighter-bomber raced over the Mojave Desert at 38,000 feet. The course was a 62.4 mile circle. With a temperature of 63 degrees below zero, the Air Force F-105D whipped through the closed-course flight to establish a new world's record of 1,216.48 mph.

Its highly advanced electronics, radar, and associated equipment, enable the F-105D to perform missions at twice the speed of sound regardless of visibility, ceilings, or target area conditions. Its speed and power make it one of the most versatile aircraft in history.

The jet engine that powers the F-105D is the Pratt & Whitney Aircraft J-75. This same engine also powers Convair's F-106 all-weather interceptor which recently set a new world's straight-away record. Over the years, the Pratt & Whitney Aircraft J-57 and J-75 jet engines have broken virtually every major flight record.

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often forced to wait for CAB consolidation orders in area route cases before they can continue with their cases. "We can't even set exhibit dates," one examiner complained, without first knowing the full scope of the proceeding. He estimated that this loss of time while awaiting CAB consolidation orders often accounts for delays of as long as eight months before the examiner can issue an initial decision. Those opposing this principle did so on grounds that issuance of such orders is more properly the policy determining function of the full CAB.

• **Findings of fact by the examiner** should be final unless proven erroneous on the basis of the entire record. Pfeiffer points out that the Administrative Procedures Act now requires agencies to refind the fact originally found by the examiner. The examiner, he added, is "the only impartial person who has both heard and observed the witnesses and studied the entire record." Pfeiffer also believes that such refindings are done by an opinion writer who must "work with a cold record" since he neither heard nor observed the witnesses.

Opinion on this issue also was divided, with many examiners pointing out that, while CAB has the authority to refind facts, it can, and often has in the past, adopted those submitted by the examiner. Several agreed with Pfeiffer, but others considered the refinding of facts by the Board as a practical safeguard or double check on details.

• **Opinion writing** could best be accomplished under the personal supervision of an agency member assigned to that duty by the chairman, Pfeiffer said. Assistants would brief the member on the case prior to oral argument and also would prepare the initial draft of a final decision under the member's personal direction. Such a practice, the examiner said, would give greater assurance to ease participants that agency members have a personal familiarity with the record and the importance of the final results.

Most examiners interviewed found little value in this suggestion and seemed to think the present system is practical. Their comments ranged from observations that the idea presents no advantage and could possibly be slower than the present method of opinion writing by a specialized staff which bases its findings on the case record and testimony. The minority feel that CAB members should be personally responsible for any opinions they sign and add that dissenting opinions are usually the personal work of Board members.

• **Final decision making** also would be expedited by expanding agency membership to avoid the problems of obtaining a quorum due to other functions, such as participation in international route negotiations and industry conventions. Pfeiffer compared this proposal to the U. S. Circuit Court of Appeals for the District of Columbia which has nine judges who often sit in panels of three. Only matters of industry-wide importance, such as the General Passenger Fare Case and the Large Irregular Air Carrier Investigation, should require the vote of the entire CAB, he said. Pfeiffer added that the situation is comparative to the "rare times" when the Circuit Court of Appeals sits in full strength.

Most of the examiners questioned were in favor of this idea and noted that the many tasks required of Board members tend to "dilute" their time. As a group, they generally favored a seven-member Board with members being permitted to specialize in duties such as bilateral negotiations, economic and safety hearings. Some pointed out that a similar system is used by the Interstate Commerce Commission but that the vast complexity of transportation work regulated by this agency makes an 11-member commission a matter of practical necessity.

• **Terms of agency members** should be at least 10 years, with possible appointment for life and rotation duty among other regulatory agencies. Salaries of the members should be increased so that the combination of salary and position security would offset any need to leave the government for private employment.

CAB Merger Decisions

Proposed merger between TWA and Northeast Airlines (AW May 23, p. 38) has again revised speculation as to how far the Civil Aeronautics Board will go in realigning route structures and services of the domestic airline industry by backing of proposed mergers between carriers. The following table compiled by Aviation Week from CAB records shows that since 1943 the Board has reacted favorably to major proposals which have had a decided effect on competition within the industry and suggests that, unless the Board's policy on mergers undergoes a drastic change, proposed future mergers that will benefit the industry's economy may get a cordial reception.

Date Filed	Airlines Involved	Approved	Denied or Dismissed
October, 1943	Western Airlines-Inland Airways	May, 1944	
June, 1944	Braniff Airways-Frontier Airlines		March, 1946
October, 1945	American Airlines-Mid-Continent Airlines		September, 1946
December, 1945	Capital Airlines-Northeast Airlines		August, 1947
May, 1948	Northeast Airlines-Wiggins Airways		December, 1951
July, 1949	Monarch Air Lines-Arizona Airways	April, 1950	
September, 1949	Monarch Air Lines-Challenger Airlines*	December, 1949	
December, 1948	Pan American Airways-American Overseas Airlines	July, 1950	
April, 1950	Southwest Airways-West Coast Airlines		December, 1949
May, 1950	Mid-Continent Airlines-Parks Airways		July, 1950
October, 1950	Continental Air Lines-Mid-West Airlines		December, 1951
December, 1951	West Coast Airlines-Empire Airways	June, 1952	
January, 1952	National Airlines-Colonial Airlines		Dismissed
January, 1952	Braniff Airways-Mid-West-Continent Airlines	May, 1952	
February, 1952	Northwest Airlines-Capital Airlines		June, 1952
April, 1952	Delta Air Lines-Chicago & Southern Air Lines	December, 1952	
July, 1952	Eastern Air Lines-Colonial Airlines	January, 1956	
October, 1952	North Central Airlines-Lake Central Airlines		January, 1957
December, 1953	Continental Air Lines-Pioneer Air Lines	December, 1954	
May, 1956	Mackey Airlines-Midget Aviation Corp.	October, 1956	

* Consolidated into Frontier Airlines.

Airlines Report Officers' Salaries to CAB

Washington—Following is a list of airline officers' and directors' salaries, bonuses and indirect compensation, expenses and stock holdings for the year ending Dec. 31, 1959, as reported to the Civil Aeronautics Board:

National Airlines, Inc.—G. T. Baker, president and director, $54,000 salary, $14,476.02 bonus and indirect compensation, $8,697.06 expenses and 199,479 shares of common stock; **J. C. Bassage**, vice president (entered office 11/1/59), $3,333.34 salary, no bonus or indirect compensation, no expenses or stock; **J. C. Brawner**, executive vice president and director, $27,000 salary, $7,866.94 bonus and indirect compensation, $898.48 expenses and 3,980 shares of common stock; **W. B. Caldwell, Jr.**, assistant treasurer, $12,000 salary, $3,933.47 bonus and indirect compensation, $2,208.67 expenses and 72 shares of common stock.

J. W. Colthar, vice president (entered office 3/16/59), $11,875 salary, $1,143.08 bonus and indirect compensation, $154.70 expenses and no stock; **R. Drake**, treasurer (entered office 7/1/59), $6,000 salary, $523.46 bonus and indirect compensation, $85.44 expenses and no stock; **L. W. Dymond**, vice president, $22,000 salary, $6,555.79 bonus and indirect compensation, $699.63 expenses and 621 shares of common stock; **R. A. Fitzgerald**, vice president, $15,000 salary, $4,916.84 bonus and indirect compensation, $1,432.77 expenses and 130 shares of common stock; **R. P. Foreman**, secretary and director, $15,000 salary, $4,916.84 bonus and indirect compensation, $1,861.88 expenses and 4,748 shares of common stock.

R. S. Grant, assistant vice president, $15,000 salary, $4,916.84 bonus and indirect compensation, $258.31 expenses and 96 shares of common stock; **A. G. Hardy**, senior vice president, $24,000 salary, $7,866.94 bonus and indirect compensation, $3,486.62 expenses and 2,596 shares of common stock; **W. F. Johnson**, vice president, $17,000 salary, $5,080.73 bonus and indirect compensation, $460.65 expenses and 2,933 shares of common stock; **J. L. Morris**, vice president, $15,458.33 salary, $4,916.84 bonus and indirect compensation, $6,224.06 expenses and 3,727 shares of common stock.

G. W. Paul, assistant vice president, $12,000 salary, $3,933.47 bonus and indirect compensation, $462.72 expenses and 3 shares of common stock; **W. A. Perry**, assistant vice president (left office 10/1/59), $9,000 salary, $3,933.47 bonus and indirect compensation, $1,012.91 expenses, no stock; **J. M. Rosenthal**, senior vice president, $24,000 salary; $7,866.94 bonus and indirect compensation, $885.59 expenses and 2,754 shares of common stock; **C. F. Sharp**, vice president, $16,500 salary, $4,916.84 bonus and indirect compensation, $1,613.08 expenses and 1,229 shares of common stock; **A. L. Stanley**, assistant vice president (entered office 11/6/59), $1,925 salary, no bonus or indirect compensation, expenses or stock.

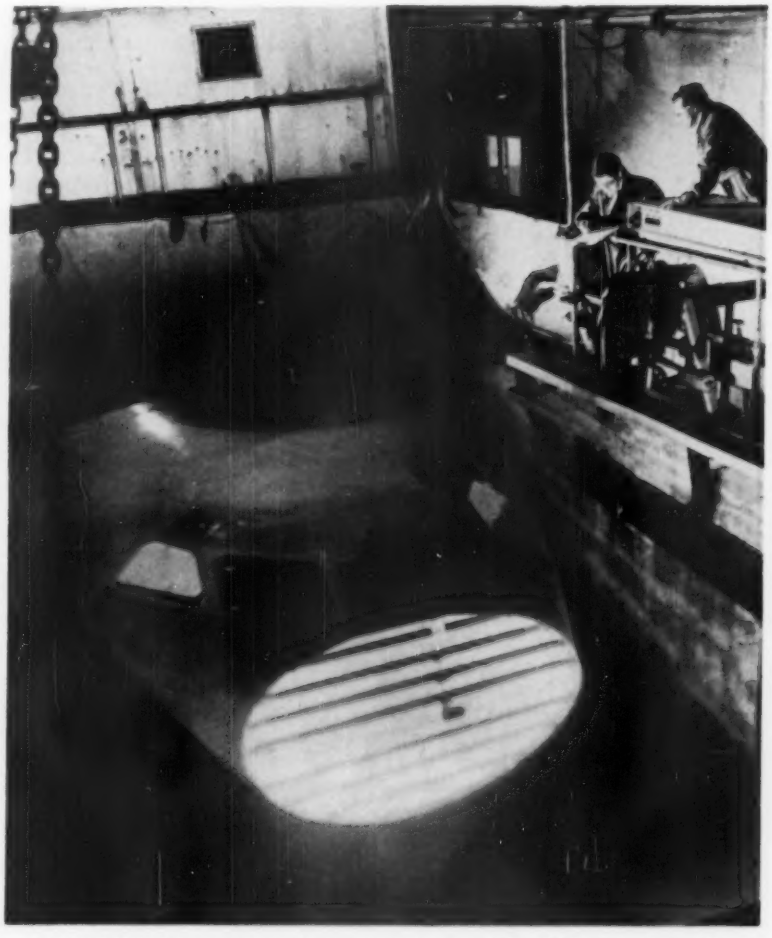
W. Sternberg, senior vice president (left office 12/31/59), $24,000 salary, $7,866.94 bonus and indirect compensation, $4,388.65 expenses and no stock; **H. B. Taylor**, assistant treasurer (entered office 4/3/59), $10,000 salary, $1,200.42 bonus and indirect compensation, $614.53 expenses and no stock; **R. E. Wieland**, vice president, $16,500 salary, $4,916.84 bonus and indirect compensation, $2,189.95 expenses and 4,006 shares of common stock; **W. C. Bruner**, assistant vice president (left office 10/15/59), $11,875 salary, $2,798.75 bonus and indirect compensation, $18.67 expenses and no stock.

Following directors were not paid a salary, bonus or indirect compensation: **J. W. Cross**, no expenses and 3,460 shares of common stock; **G. W. Gibbs, Jr.**, $300 expenses and 73 shares of common stock; **E. C. McDonald**, $600 expenses and 601 shares of common stock; **A. G. McNeese, Jr.**, $450 expenses and 135 shares of common stock; **P. R. Scott**, no expenses and 2,474 shares of common stock; **D. R. Topping**, $150 expenses and 2,474 shares of common stock; **J. A. Waterman**, $600 expenses and 624 shares of common stock; **B. Winters**, $450 expenses and no stock.

Following firms were paid for services rendered during 1959: **Denning & Wohlstetter**, legal services, $6,544; **John W. Cross**, legal services, $48,652; **Scott, McCarthy, Preston, Steel & Gilleland**, legal services, $38,973; **Gotch & Crawford**, statistical services, $16,021; **Ernst & Ernst**, managerial consultants, $79,084; **Johns Hopkins University**, medical services, $9,084; **Communications Counselors, Inc.**, public relations, $151,315; **Wenchell, Schulman & Manning**, legal services, $20,730; **Market Planning Corp.**, public relations, $17,325; **Cravath, Swain & Moore**, legal services, $13,034; **Investigators, Inc.**, management research services, $6,224; **Metropolitan Life Insurance Co.**, financial consultants, $10,739; **Alexander & Alexander**, actuarial services, $7,830; **Haskins & Sells**, auditing services, $11,000.

Northeast Airlines, Inc., (carrier did not list bonuses or indirect compensation)—**J. W. Austin**, president and director, $36,000 salary, $2,616 expenses and no stock; **J. S. Daniels**, assistant vice president-promotion and advertising, $14,400 salary, $3,280 expenses and 200 shares of common stock; **N. B. Fry**, vice president-traffic and sales, $20,000 salary, $3,065 expenses and 300 shares of common stock; **G. E. Gardner**, (resigned as chairman of the board 2/6/59 and assumed position of assistant to the board 2/7/59), $25,326 (includes salary for entire year), $3,350 expenses and 100 shares of common stock; **T. L. Grace**, vice president-operations (entered office 4/20/59), $17,532 salary, $823 expenses and no stock; **H. Heard**, vice president-administration, $15,000 salary, $207 expenses and no stock; **R. H. Kerr** (left office 9/30/59), $15,000 salary (includes salary for entire year), $456 expenses and no stock.

A. A. Lane, vice president-operations (left office 4/6/59), $18,738 (includes salary for entire year), $1,758 expenses and no stock; **R. P. Lane, Jr.**, (resigned as treasurer 4/6/59 and assumed position as vice president & treasurer 4/7/59), $19,000 salary,



DH-121 Nose Section Is Tested in Water Tank

British Airco DH-121 nose section is subjected to static and fatigue pressure testing in a water tank at the de Havilland plant at Hatfield, England. When this photo was taken the nose section had just been under a pressure of 11 psi., which is one and one-third times the normal operating cabin pressure. A test is now in progress in which the section is subjected to stresses equivalent to 40,000 flights of 1½ hr. duration, equal to 60,000 flying hours or about 20 years of service.

$684 expenses and no stock; **D. W. H. McKinnon**, vice president-maintenance & engineering (left office 2/6/59), $12,304 salary (includes salary for entire year), $28 expenses and no stock; **W. W. Meis**, assistant vice president-production, $12,000 salary, $128 expenses and 100 shares of common stock.

M. H. Offutt, III, assistant vice president-manager of general sales (entered office 10/12/59), $12,000 salary, $7,060 expenses and no stock; **E. O. Schroeder**, vice president-technical services (entered office 4/7/59), $18,365 salary, no expenses and 200 shares of common stock; **A. S. Walker, Jr.**, vice president-ground operations, $14,400 salary, $499 expenses and no stock; **H. F. Zimmerman**, $14,000 salary, $19 expenses and no stock.

Following directors were not paid a salary: **J. Cochran**, $200 expenses and 1,000 shares of common stock; **P. F. Collins**, $300 expenses and 100 shares of common stock; **J. F. Fitzgerald**, $300 expenses and 500 shares of common stock; **H. E. Foley**, clerk of the corporation, no expenses and 900 shares of common stock; **R. Iremescu**, $450 expenses and no stock; **A. G. McMenimen**, $450 expenses and 300 shares of common stock; **D. A. Stretch**, chairman of the board, $350 expenses and no stock; **E. L. Vidal**, $300 expenses and 13,000 shares of common stock; **L. P. Whittemore**, $250 expenses and 100 shares of common stock.

Following firms were paid for services rendered during 1959: **J. Walter Thompson Co.**, advertising, $1,508,622.33; **Connell Price & Co.**, actuaries, $5,316.97; **Ray Smith & Associates**, public relations, $7,257.60; **Foley, Hoag & Eliot**, legal, $90,443.73; **Walton, Lantaff, Schroeder, Atkins, Larson & Wahl**, legal, $5,281.56; **Lybrand, Ross Brothers & Montgomery**, auditors, $15,775; **Gus W. Campbell & Associates**, personnel consultants, $6,105.51.

United Air Lines (carrier did not list bonuses, indirect compensation or expenses) —**W. A. Patterson**, president and director, $100,000 salary, 10,980 shares of common stock and 279 shares of common stock in name of others; **J. A. Herlihy**, senior vice president-engineering and maintenance and director, $55,000 salary and 2,555 shares of common stock; **D. F. Magarrell**, senior vice president-transportation services and director, $55,000 salary and 2,032 shares of common stock; **R. E. Johnson**, senior vice president-sales and public relations and director, $52,000 salary and 2,670 shares of common stock.

D. R. Petty, senior vice president-flight operations, $53,000 salary and 2,407 shares of common stock; **C. Barkes**, senior vice president-finance and property and director, $52,000 salary and 4,999 shares of common stock; **R. F. Aberns**, senior vice president-personnel, $42,000 salary, 3,631 shares of common stock and 62 shares of common stock in name of others; **H. E. Sourse**, senior vice president-economics controls, $34,000 salary and 4,660 shares of common stock; **C. F. McErlean**, vice president-law and assistant to the president, $35,000 salary and 1,009 shares of common stock; **S. P. Martin**, secretary of the corporation and assistant to the president, $22,000 salary and 1,293 shares of common stock.

R. E. Bruno, comptroller and assistant secretary of the corporation, $26,500 salary, 251 shares of common stock and 28 shares of common stock in name of others; **A. M. de Voursney**, vice president and treasurer, $27,000 salary and 400 shares of common stock; **W. P. Hoars**, vice president-maintenance (retired 11/1/59), $26,204 salary and no stock; **G. E. Keck**, vice president-maintenance (entered office 11/1/59), $25,750 salary and 355 shares of common stock; **O. T. Larson**, vice president-ground services, $30,000 salary, 395 shares of common stock and 311 shares of common stock in name of others.

O. C. Enge, vice president-passenger services, $26,000 salary, 511 shares of common stock and 314 shares of common stock in name of others; **I. E. Sommermeyer**, vice president-flying, $34,100 salary, 492 shares of common stock and 274 shares of common stock in name of others; **J. M. Hodgson**, vice president-flight administration, $31,700 salary and 659 shares of common stock in name of others; **B. B. Gragg**, vice president-marketing, $29,400 salary, 849 shares of common stock and 314 shares of common stock in name of others; **R. M. Ruddick**, vice president and assistant to the president, $20,000 salary and 54 shares of common stock; **J. E. Moore**, vice president-traffic, $25,000 salary and 546 shares of common stock; **W. C. Mentzer**, vice president-engineering, $35,500 salary and 1,083 shares of common stock.

H. J. Merchant, vice president-sales manager, $26,500 salary, and no stock; **D. V. O'Leary**, vice president-purchasing and stores, $26,500 salary and 461 shares of common stock; **D. C. Meenan**, vice president-facilities and properties, $21,400 salary and 600 shares of common stock; **C. M. Mason**, vice president-employe relations, $26,000 salary and 141 shares of common stock; **T. Lee, Jr.**, vice president-education and training (retired 1/1/60), $19,500 salary and no stock; **L. F. Hampel**, vice president-business research, $20,600 salary and 28 shares of common stock; **W. E. Alberts**, vice president in charge of industrial engineering, $21,200 salary and 144 shares of common stock.

M. C. Ansorge, director, $3,400 salary and 940 shares of common stock; **P. A. Bissinger**, director, $3,400 salary and 2,010 shares of common stock; **H. T. Brown**, director, $3,600 salary and 352 shares of common stock; **G. Cowles**, director, $3,200 salary and 9,693 shares of common stock; **J. W. Dart**, director, $3,200 salary and 13,862 shares of common stock; **T. F. Gleed**, director, $3,400 salary, 225 shares of common stock and 2,373 shares of common stock in name of others; **P. G. Hoffman**, director, $3,200 salary and 1,226 shares of common stock; **E. A. Johnston**, director, $3,200 salary and 5,006 shares of common stock; **J. J. Mitchell**, director, $3,300 salary and 5,006 shares of common stock; **A. Nielson**, director, $3,600 salary and 789 shares of common stock; **V. Stouffer**, director, $3,100 salary and 1,627 shares of common stock.

Following firms were paid for services rendered during 1959: **Arthur Andersen & Co.**, audit and related, $54,867; **John C. Bowers Co.**, property management services, $14,444; **Ragnar Benson, Inc.**, architecture and engineering, $40,247; **Brobeck, Phleger & Harrison**, legal, $22,315; **B. M. Doolin**, airport consulting service, $9,000; **Edwin A. Francis**, architecture, $74,730; **Haight, Garner, Poor and Havens**, legal, $6,641; **John L. Hunter**, architecture and engineering, $5,980; **Hardin, Hess & Eder**, legal, $10,363; **Raymond Loewy Associates**, designing services, $72,943; **Loubet & Glynn**, architecture and engineering, $10,248; **Mayer, Friedlick, Spiess, Tierney, Brown & Platt**, legal, $316,313.

McAfee, Hanning, Newcomer & Hazlett, legal, $5,822; **George H. Miehls**, architecture, $34,559; **Marris, Nichols, Arnacht & Tunnell**, legal, $6,584; **George P. Nixon & Co.**, legal, $7,500; **James Francis Rielly**, legal, $35,000; **John R. Steelman**, economic consultant, $12,000; **Paul R. Reddy**, architecture, $14,107; **Skidmore, Owings & Merrill**, architecture, $159,138; **Harold L. Sleight**, architecture, $18,297; **Trippet, Yoakum, Stearns & Ballantyne**, legal, $7,927; **Woodford & Bernard**, architecture, $8,946; **Young, Richardson & Carleton**, architecture, $14,681.

Atlantic Route Mergers Foreseen

New York—There are too many carriers on the North Atlantic, and the trend is toward mergers on the route, according to Air-India International Chairman J. R. D. Tata.

The Indian airline this month inaugurated its first service to the United States with thrice-weekly Boeing 707-420 schedules.

However, Tata pointed out here last week, Air-India believes its entry into the transatlantic market is appropriate despite the plethora of airlines. India, he said, is a huge country beginning an enormous economic expansion and it is logical that Air-India will play a part in this development. Criteria as to whether a carrier belongs on the Atlantic or not, Tata said, are the origin and destination of its traffic. The mere fact that an airline historically has flown the route, he said, doesn't qualify it.

Air-India had to enter the transatlantic market sooner or later, the chairman said, and he believes it picked the right time.

Jet Economics

Traffic to fill the expanded jet fleets will be available worldwide for at least a year, Tata said, but after that the situation might change. Full maturity and success of the airline business awaits mass level fares, he acknowledged, but economic considerations will preclude much chance of marked fare reductions in the near future. Jets must be paid for and more experience with them and knowledge of their operating costs must be accumulated first, Tata noted.

Service frills, despite some arguments to the contrary, are not a dominating factor in operational costs, amounting to perhaps 5%, Tata said. Even accepting the fact that some carriers operate inefficiently, he added, the more efficient carriers with good load factors still show small profits, and so unwarranted costs are not the chief factor in keeping fare levels high.

Air-India's Super Constellation services to Moscow do well against Aerflot's Tu-104 jets, Tata said. The two carriers operate under a pool agreement and, according to the Air-India official, his airline has to turn revenue over to Aeroflot, meaning Air-India carries more of the pool's passengers. The Tu-104's flight time between Bombay and Moscow is 7 hr., he said, against 13 hr. for the Super Constellation.

Market Decision

Air-India could have entered either the Atlantic or Pacific markets with its new jets, Tata said, but decided on the former and must "digest" that service before making plans for the Pacific. Its fleet of four 707-420s will keep busy on the present routes and additional equipment will be decided on before such expansion is undertaken.

Tata predicted an 8-10 year period before supersonic transports appear in airline service. Subsonic jets then will still be needed for backup services, he said. The Air-India chairman also remarked that his airline has nine Super Constellations "for which we are quite prepared to accept offers."

UNITED AIR LINES

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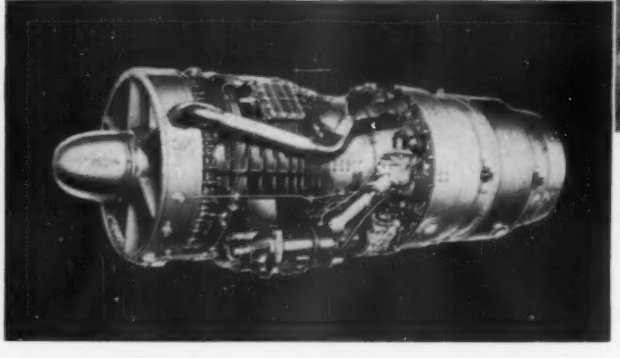

Avon turbo-jets of from 10,500 to 12,725 lb. thrust power all the 80 Sud Aviation Caravelles now in service with, or on order for, 10 airlines.

The RB.141 by-pass jets of 15,000 lb. take-off thrust is available to power later Caravelles.

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SHORTLINES

► **British West Indian Airways** reports that it carried 215,099 passengers a total of 97,244,486 revenue passenger miles in 1959—increases of 43% and 48% respectively over 1958. BWIA also recently began transatlantic service to the Caribbean, with weekly flights from London to Barbados and Trinidad and from London to Jamaica, both via New York.

► **Civil Aeronautics Board** began oral arguments late last week in the St. Louis-Southeast Service Case. Trans World Airlines had been given authority by CAB to fly from St. Louis to points in Florida and Georgia and had begun this service, stopping at St. Louis on direct flights to and from the West Coast. American Airlines, National Airlines, Delta Air Lines and Eastern Air Lines petitioned the U.S. Court of Appeals to vacate TWA's authority to service the route on direct flights, and the court ruled in their favor. The Board then issued an order permitting TWA to service the route so long as flights were terminated at Nashville or St. Louis.

► **Eastern, Mackey, National,** Northeast Airlines, Capital, Delta and Northwest Airlines have received Civil Aeronautics Board permission to fly mail between Ft. Lauderdale and Miami, Fla., for a period of two years.

► **Trans Caribbean Airways** has been recommended by a Civil Aeronautics Board examiner to receive rights to carry mail on a nonsubsidy basis from New York to Puerto Rico over the objections of Eastern Air Lines, Pan American World Airways and Riddle Airlines. The three interveners contend that Trans Caribbean does not need the additional revenue which, they say, would be diverted from them, and that the service between New York and Puerto Rico as now provided by the three carriers is adequate.

► **Western Air Lines** has received exemption from the Federal Aviation Act permitting it to lease an additional 14 Allison Model 501-D13 turboprop engines and 14 Aeroproducts Model A 4661 FN-606 propellers from Al-West, a subsidiary of General Motors Corp. Western had previously leased approximately 45 Allison turboprop engines and 43 Aeroproducts propellers. Cost to Western is $88,950 per engine and $23,600 per propeller, which will be amortized over a period of five years in 20 quarterly installments at 6% interest on the unpaid balance.

AIRLINE OBSERVER

► **Delta Air Lines scheduling program calls for the introduction of either Douglas DC-8 or Convair 880 turbojet transports into 18 cities on its system by October. At that time, the airline will be operating a higher percentage of seat miles with turbojet than with piston-engine equipment.**

► Watch for new moves by the airline industry to block avowed attempts by rail carriers to acquire other forms of transportation. In latest test case, Air Transport Assn. has petitioned the Interstate Commerce Commission for permission to intervene in hearings on application of railroads to acquire water carriers. Airline officials are alarmed that railroaders will next move to the air transport field if successful in acquiring other forms of surface transportation.

► **Eastern Air Lines has completed major operating policy changes undertaken during the past six months. Principal result has been a sharp reduction in available seat miles which, in April, produced the highest monthly load factor the airline has recorded in 2½ years. Customer service department, organized under the direction of Robert Turner, has been fully established in a majority of the carrier's stations. Purpose of the new department is to free sales organization of procedural and administrative burdens so salesmen can concentrate on selling. Customer service, according to Eastern, "delivers the goods sales has sold."**

► Soviet Premier Nikita Khrushchev has found a new source of irritation in U.S. aerial activity: U.S. jet aircraft which kept him awake during the summit meeting in Paris. "I've had enough of American jet planes," he said, "I'm sick of them." This complaint came when a photographer asked him why he left the summer home of Soviet Ambassador Sergei Vinogradov, near Paris' Orly Field, after one night and slept thereafter in the USSR Embassy in Paris. "You know all about the one that flew over our country—the U.S. espionage plane," he replied. "Then I come to Paris . . . and the noise of those American Air Force jet planes taking off and landing at Orly Airport, they ruined my sleep." Orly is also the scene of considerable jet transport traffic, including Boeing 707 and Douglas DC-8 turbojet transports operated by international carriers, as well as turbojet Tu-104s flown by Aeroflot, the Soviet airline.

► **Sen. Clair Engle (D.-Calif.) has introduced two bills in the Senate to ensure that the powers of the Administrator of the Federal Aviation Agency are exercised reasonably. Sen. Engle, who locked horns with FAA chief E. R. Quesada on several occasions during recent Senate Aviation Subcommittee hearings, said the purpose of the bills is to establish reasonable safeguards for licensed pilots under the administrator's authority.**

► Pan American World Airways will continue its program at New York International Airport of using a ground radio car to tell turbojet pilots when to cut power after takeoff so aircraft will create a minimum of noise over surrounding communities, whether or not the airport's noise regulations are made less stringent. This "Test Able" station wagon is manned on a full-time basis, as it has been since turbojet operations began. Similar system is used at London Airport. Station wagon sits off the end of runway, completes 5-4-3-2-1 "countdown" to pilot who cuts power at end of countdown. This avoids cutting power back too soon, which would put aircraft lower over community, or too late, which would put aircraft over other settled areas with higher power. Pan American studies of noise performance of its aircraft indicate the Boeing 707-320 is better than the Boeing 707-120 in this respect.

► **MALEV, Hungary's state-owned airline, expects to double passenger traffic during the nation's second five-year plan—1961-65. The carrier's goal is 226,000 passengers in 1965. Hungarian aviation officials estimate that by 1965, about 70% of the transports arriving in the country from foreign points will be turboprop-powered, about 20% will be turbojet aircraft and only 10% will be piston-powered. MALEV expects to be operating Russian-built Il-18 turboprop transports "shortly."**

Airline Traffic—March, 1960

	Revenue Passengers	Revenue Passenger Miles (000)	Passenger Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-all Revenue Load Factor %
DOMESTIC TRUNK								
American	636,660	463,924	60 7	1,909,291	1,309,193	9,168,701	56,803,825	54 1
Braniff	187,085	84,947	51 3	410,640	168,215	650,596	9,374,865	43 0
Capital	286,637	121,688	49 3	538,610	294,399	446,170	12,944,289	45 3
Continental	100,015	62,806	48 3	146,698	111,250	306,664	6,593,186	38 0
Delta	272,728	153,480	58 2	458,556	288,112	1,333,302	16,859,564	49 0
Eastern	673,272	374,624	52 42	1,295,344	515,454	1,770,095	39,723,120	42 71
National	147,498	102,927	56 5	342,510	67,663	650,650	11,052,727	45 2
Northeast	103,520	48,870	50 8	140,407	39,788	203,818	5,065,049	44 3
Northwest	148,765	111,629	52 4	673,338	292,799	1,615,039	13,318,145	48 0
Trans World	384,159	322,758	57 2	1,795,744	798,358	3,238,894	36,748,200	49 8
United	531,448	357,042	59 1	2,722,638	898,426	6,271,426	44,180,690	54 8
Western	142,442	77,914	56 5	356,442	106,062	342,392	8,280,666	50 1
INTERNATIONAL								
American	10,803	11,516	72 9	9,482	499	181,308	1,380,608	72 2
Braniff	4,420	8,239	46 0	22,488	.....	126,318	1,036,402	41 4
Caribbean Atlantic	34,163	2,426	63 1	2,048	.....	8,309	266,884	69 9
Delta	2,194	2,916	34 0	7,828	.....	30,867	360,131	33 2
Eastern	34,103	50,008	53 52	97,612	.....	165,545	5,428,690	53 85
Mackey	14,651	2,746	44 3	.....	261	5,571	302,245	41 0
National	1,581	1,280	30 9	2,025	1,767	13,348	152,504	28 5
Northwest	15,059	27,608	46 9	1,267,698	17,114	1,048,363	5,268,570	52 4
Pan American								
Alaska	3,804	3,795	34 4	32,407	.....	135,466	565,165	34 1
Atlantic	87,135	122,641	61 6	1,300,875	.....	4,255,795	18,505,276	56 9
Latin America	98,524	115,252	66 4	439,257	.....	4,183,716	16,277,031	66 8
Pacific	33,025	116,363	70 7	1,827,596	.....	2,197,950	16,244,338	60 0
Panagra	11,008	16,770	63 1	81,284	.....	503,669	2,402,689	64 9
Resort	.....	.....	.....	.....	.....	3,413,851	3,413,851	19 2
Trans Caribbean*	.....	.....	.....	.....	.....	.....	.....	.....
Trans World	20,442	59,784	60 3	1,068,929	.....	1,456,168	8,822,604	60 5
United	9,350	23,211	80 0	146,104	9,317	106,756	2,623,330	70 5
Western	4,332	6,736	64 0	10,419	.....	24,060	745,938	67 6
LOCAL SERVICE								
Allegheny	42,561	7,474	41 8	12,938	22,519	29,653	778,203	40 4
Bonanza	22,802	5,679	42 4	9,649	2,926	11,381	569,245	43 8
Central	12,614	2,470	36 7	7,637	3,156	9,994	257,658	33 5
Frontier	25,950	6,791	35 3	27,579	9,681	60,931	752,604	39 6
Lake Central	18,923	2,951	36 4	5,044	17,609	.....	304,869	39 7
Mohawk†	24,593	4,769	42 5	10,177	9,991	11,117	485,652	39 9
North Central	76,597	13,249	40 28	43,249	42,530	32,714	1,402,648	41 45
Ozark	42,897	7,536	38 7	15,908	24,976	27,952	789,822	41 1
Pacific	38,669	8,818	44 6	16,598	4,554	8,769	870,934	51 0
Piedmont	29,376	6,097	38 5	10,069	11,163	14,748	621,937	39 7
Southern	24,091	4,316	31 5	14,453	10,908	15,484	455,195	33 1
Trans-Texas	24,560	5,695	36 1	21,229	12,518	40,010	618,592	37 5
West Coast	31,722	7,313	41 61	14,110	4,806	17,716	735,050	41 82
HAWAIIAN								
Aloha	21,118	3,674	54 9	2,257	.....	7,357	308,718	52 2
Hawaiian	34,772	7,390	53 9	80,224	.....	337,734	1,080,427	53 1
CARGO LINES								
AAXICO*	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana	.....	.....	.....	.....	.....	544,662	544,662	83 8
Flying Tiger	571	1,245	89 7	62,480	104,272	9,943,211	10,234,404	79 0
Riddle								
Domestic	.....	.....	.....	8,742	26,381	1,691,232	1,725,355	74 0
Overseas	.....	.....	.....	6,956	.....	454,982	461,938	69 5
Seaboard & Western	2,669	10,442	100 0	536,579	.....	5,550,353	7,145,320	83 3
Slick	5,651	5,993	100 0	.....	.....	7,546,575	8,145,143	100 0
HELICOPTER LINES								
Chicago Helicopter	24,761	427	53 3	1,098	.....	.....	41,876	44 5
Los Angeles Airways	2,802	97 8	54 9	4,962	2,448	.....	16,784	63 3
New York Airways	9,645	200	49 6	1,355	968	595	22,003	49 1
ALASKA AIRLINES								
Alaska Airlines	8,893	7,116	54 4	68,266	4,407	282,603	1,054,944	57 7
Alaska Coastal*	.....	.....	.....	.....	.....	.....	.....	.....
Cordova	1,518	377	30 7	3,600	.....	37,142	78,892	51 4
Ellis	3,493	210	48 4	2,003	.....	2,456	25,857	59 6
Northern Consolidated	1,821	551	31 8	42,063	.....	57,736	160,462	55 1
Pacific Northern	6,659	5,773	31 1	112,917	5,760	235,445	982,407	43 1
Reeve Aleutian	1,194	1,065	29 4	47,261	.....	60,020	224,511	54 4
Western Alaska	205	16	54 3	545	.....	575	2,633	55 1
Wien Alaska	2,708	651	34 1	41,016	.....	54,521	162,929	45 5

† Operations interrupted Mar. 18 through Apr. 2 because of strike. * Not available.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

3M COMPANY CHEMICALS THE RAW MATERIALS OF PROGRESS

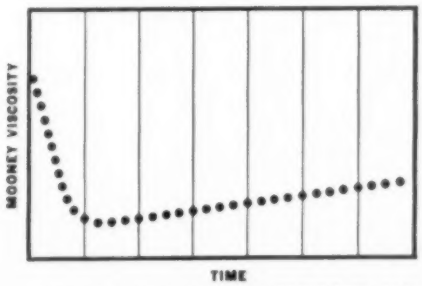
NEW FLUOREL® 2141

BRAND ELASTOMER

Its Mooney Scorch Rating is ideal for the fluorinated rubber processor because it makes possible fast, more economical cures with fewer defects, less scrap, fewer rejected parts. Material can be reprocessed with greater safety.

A SIGNIFICANT BREAKTHROUGH in elastomer processing has been made possible by 3M research through development of its new FLUOREL 2141 Elastomer.

This remarkable new product has a Mooney Scorch Rating outstanding among fluorinated elastomers. The range permits the rubber processor to achieve fast, more economical cures with fewer defects, less scrap and fewer rejected parts. The inherent safety of FLUOREL Elastomer 2141 allows repeated reprocessing to produce high quality parts that meet military specifications or other critical end uses.



MOONEY SCORCH CURVE for FLUOREL 2141 Brand Elastomer.

At the same time, the outstanding physical qualities of the elastomer are retained. They include: non-combustibility, excellent resistance to corrosive chemicals, fuels, solvents and ozone, minimum compression set, rated for continuous service at 400° F., and the ability to tolerate 600° F. temperatures for reduced periods under certain service conditions.

If you use or work with elastomeric materials, it will pay you to examine the remarkable features of this new product. Examine, too, your present rubber products with an eye toward increasing their life and quality through use of FLUOREL 2141 Elastomer. For complete data, write today on your company letterhead to: 3M Chemical Division, Dept. KAW-50, St. Paul 6, Minnesota.

FLUOREL 2141 "O" ring, bottom. Note freedom from defects because of the improved scorch characteristics of FLUOREL Elastomer "O" ring as opposed to elastomer at top of photograph.

"FLUOREL" is a reg. T.M. of 3M Co.

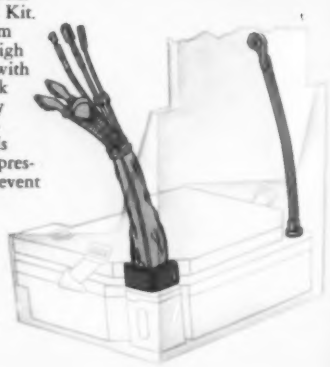
CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

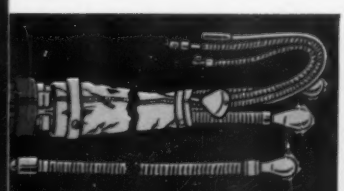
U.S. Navy F4H-1 Phantom II, with Scott Survival Kit. Pressure system controls the high vent air flow with minimum back pressure. Navy Mark IV Full-Pressure Suit is automatically pressurized in the event of cockpit pressure failure or ejection.



The Scott Suit Controller, Manifold Assembly, Oxygen Supply Container and Quick Disconnects are compactly packaged and provide accessibility for maintenance and service.

B-58 ESCAPE CAPSULE

Most advanced of escape systems. Now in production for the B-58 "Hustler" by Stanley Aviation. Pressurization, during loss of cockpit pressure or during ejection and descent, is provided by the Scott Automatic Pressure Sensing and Controlling System. Operates on ship, or integral emergency air supply.



Personal Leads Disconnect Assemblies, with full-pressure suit and standard flight suit interchangeability.

Manifold Assembly with pressure reducer, resettable on-off valves, gauges etc.

All Scott Components shown, fully comply with existing MIL Specifications.

ENVIRONMENTAL IN FLIGHT

SCOTT LEADS IN THE PRODUCTION OF

High Pressure Spiral Cylinder. Greatest gas volume in limited space envelope.

Vent Exhaust Disconnect Assembly with positive Lock and integrated release.

Suit Controller. Highest vent flow with minimum back pressure; water-tight integrity.

The U. S. Military Pilot is the best protected airman in the World. This is the result of complete cooperation of Defense Department personnel, and Airframe and Accessory Manufacturers, in the creation, development, production and maintenance of protective pilot equipment. Such protection assures an overwhelming chance for survival in the event ejection is necessary. Consideration for his safety and *comfort* also assures maximum efficiency to guarantee a high percentage of completed flight missions. Oxygen Breathing and Suit Pressurization equipment is a vital element of this protection.

The most recent development in a 20-year Scott Oxygen Equipment Research Program is a building-block concept utilizing a combination of individual, modular

Scott

AVIATION CORPORATION

Export: Southern Oxygen Co., 250 West 57th Street, New York 19, N. Y.

PROTECTION OR EJECTION

HIGH ALTITUDE SURVIVAL EQUIPMENT

High Pressure Standard Cylinder Assembly. Designed for compact integration with other Scott components.

Manifold Assembly designed for integration of Modular "Drop-in" Assemblies.

Suit and mask regulator for breathing and Partial-pressure Suit Systems.

components — each one of which has been designed and developed for a particular function. By combining selected modular components, a complete unit can be produced to serve any desired function in an Ejection Seat Oxygen System. Components may be unitized or distributed throughout the seat or airframe structure.

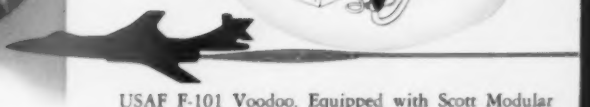
Since the individual components have already been designed, developed, proven and qualified, the *reliability* of the unit is much higher and the cost of its engineering development considerably lower than would be the case in engineering a completely new system for each application. Lead time is substantially reduced. In addition to a better system at a lower cost, a high degree of flexibility in configuration is attained.

275 ERIE STREET, LANCASTER, NEW YORK

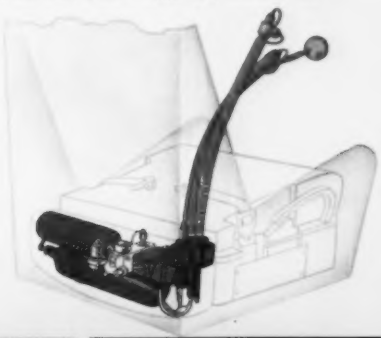
West Coast Office: Fulton-Ventura Building, 13273 Ventura Boulevard, Studio City, California

USAF F-102 Delta Dagger. Equipped with Scott Global Survival Kit. The Scott Modular "Drop-in" Oxygen System provides complete system interchangeability.

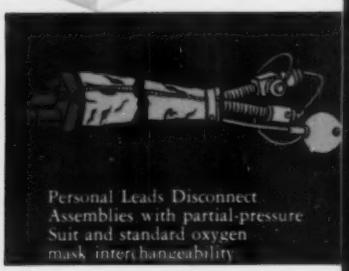
USAF F-106 Delta Dart. Equipped with Scott Modular "Drop-in" Oxygen System installed in the new supersonic Model "B" Ejection Seat.



USAF F-101 Voodoo. Equipped with Scott Modular "Drop-in" Oxygen System. Features increased emergency oxygen supply, actuated by a fully automatic pressure differential triggering mechanism.



Disconnect Assembly supplies O_2 from Kit-to-Man personal leads.



Personal Leads Disconnect Assemblies with partial-pressure Suit and standard oxygen mask interchangeability.

Dedicated, imaginative Engineers can find full expression for their talents at Scott Aviation Corp. Write in confidence to Walter H. Winter, Personnel Director.

NO MATTER HOW YOU LOOK AT THE *Comanche* ITS SUPERIOR FEATURES STAND OUT!

Automatic Flight! No feet, no hands. Piper Auto-Control, standard on the AutoFlite Comanche, holds any desired course to the exact degree, makes turns automatically. Takes the work out of flying, leaves the fun in.

Superb Lycoming Power! Your choice of 250 horsepower for over-180-mph cruise, sensational get-up and go . . . or 180 hp for 160 mph cruise and maximum economy.

Comfort De Luxe! No cramped feeling in the Comanche. Cabin is larger, roomier than in any other single-engine 4-place plane. All seats have adjustable backs. Complete new cabin air system provides just-right temperature, summer or winter.

Highest Efficiency! Laminar flow wing plus clean design gives you top efficiency, proved by two world non-stop distance records — 6967 miles with 180 hp; 7668 miles with 250 hp.

Best Price! Compare the Comanche with any retractable-geared all-metal plane. Chances are the difference in base price pays for all the extra radio and equipment you'd ever want. $15,800 for the 180 hp Comanche; only $19,800 for the Comanche 250.

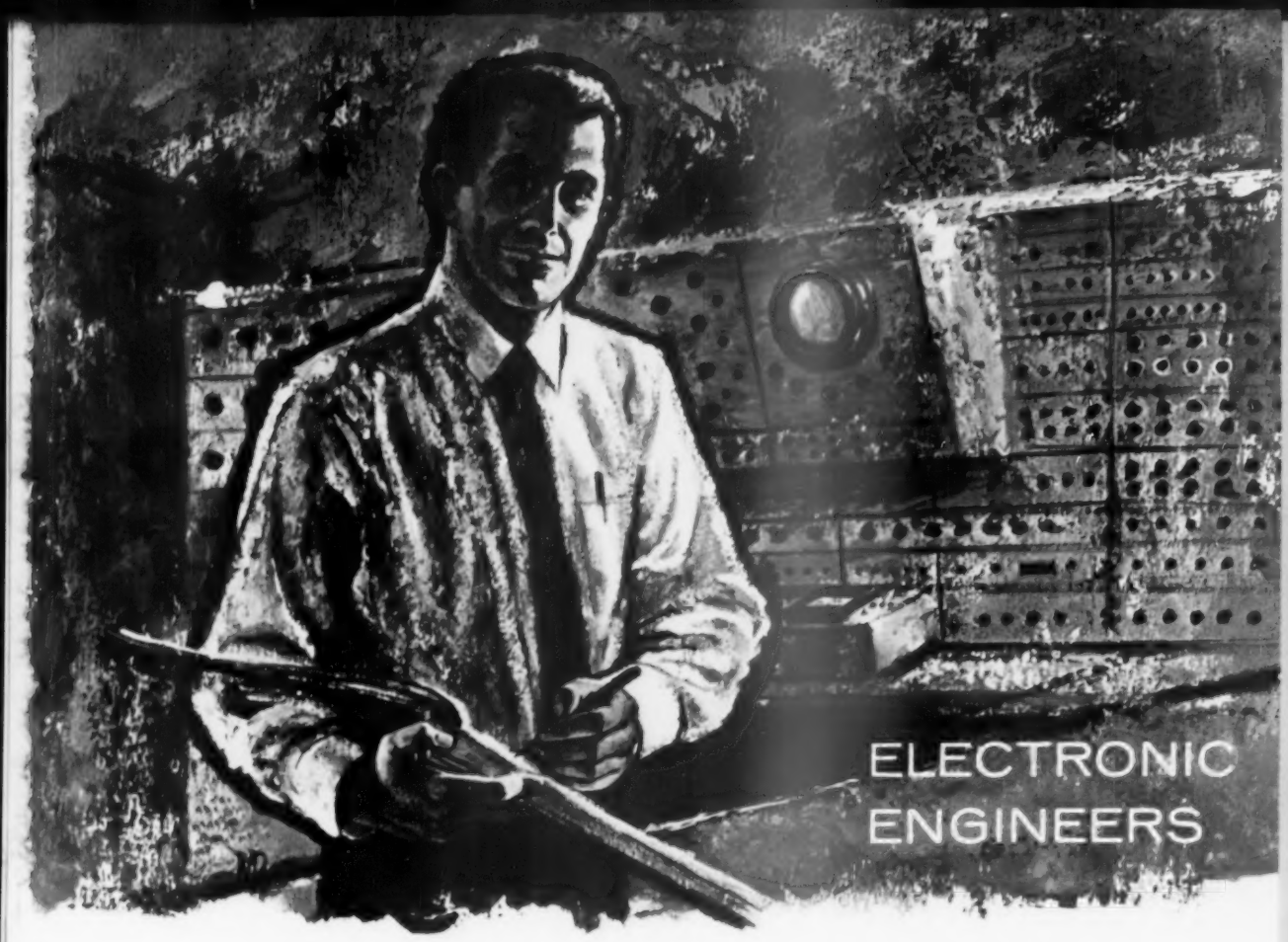
Biggest Useful Load! In either horsepower category, the Comanche gives you the largest useful load, lets you carry four passengers, full fuel with weight left over for baggage, other equipment.

See your Piper dealer for a demonstration or write for Comanche brochure, Dept. 6-W.

PIPER

AIRCRAFT CORPORATION

Lock Haven, Pennsylvania



"Tell me with whom thou art found, and I will tell thee who thou art."—Goethe (1749-1832)

These words, written more than 150 years ago, are as true today, if not truer, than they were then. To the engineer today, they emphasize the immense importance of deciding on a wise and fruitful professional association.

At Convair Astronautics, the Electronic engineer enjoys the freedom and prestige afforded men who are creating and testing the space and missile systems of the future.

Currently, Convair Astronautics needs Circuit Designers for systems design and integration of:

1) Launch control circuits. These are relay and transistorized open loop, and sequential switching circuits for the automatic control of the countdown process for the Atlas missile.

2) Test Equipment design. Switching and analogue circuitry for automatic test and checkout equipment. Assignment will be of a project nature from conception to production.

3) Tracking systems design. Communications, pulse and phase shift techniques for the design of ultra-precise missile and satellite tracking systems.

4) Telemetering design. Communications, modulation, and data sampling techniques for telemetering and data acquisition systems.

Inquiries are also invited from scientists possessing doctorate degrees and the desire to do research beyond the state of the art in communication techniques and solid state devices.

You will be associated with Convair-Astronautics, the company that designed, builds and tests this country's first intercontinental Ballistic.

These positions provide stability, growth opportunity and the satisfaction of working on a program which is both highly advanced and of vital significance to the future of the free world.

You will find more information on the back of this page and a convenient, confidential Engineering Placement Inquiry. A prompt reply to your inquiry will be forthcoming from Mr. R. B. Merwin, Engineering Personnel Administrator, Dept. 130-90, Convair Astronautics, 5653 Kearny Villa Road, San Diego, California.

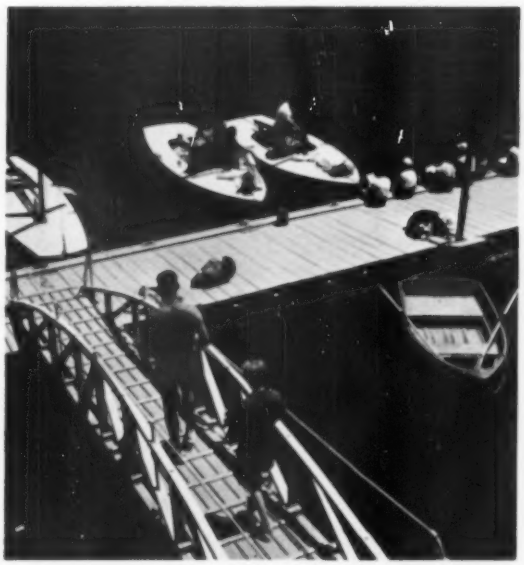
CONVAIR / ASTRONAUTICS

CONVAIR DIVISION OF GENERAL DYNAMICS

ENGINEERS AND SCIENTISTS

The Electronics Engineering Department of Convair Astronautics is located in San Diego, California, the third fastest growing community in the United States. Situated 10 miles north of the Me ican border and a little over 100 miles south of Los Angeles, San Diego and its environs enjoy a year round mild, sunny climate with smog-free air. The 30 miles of coastline are dotted with private and public beaches, inlets, and bays where fishing and water sports prevail year long. Engineers and scientists find the temperate climate and variety of after hour activities add up to superb living and working conditions all within 15-20 minutes from home.

Convair-Astronautics' plant is one of the largest and newest facilities in the free world for research, development and production of long-range missiles and space vehicles.



Engineers and scientists, if you desire to become part of this great team, we urge your prompt inquiry on the attached Engineering Placement Inquiry. Training and experience in one or more of the following areas is desired:

Technical Writing • Field Engineering • R. F. Systems • Technical Instruction • Human Factors • Landlines • Launch Control Systems • Closed Loop TV Systems • Telemetering • Ground Support Equipment • Autopilot • Guidance • Systems Checkout.

Technical openings also exist in other specialties. Write Mr. R. B. Merwin, Engineering Personnel Administrator, Dept. 130-90, Convair-Astronautics, 5653 Kearny Villa Road, San Diego, California.

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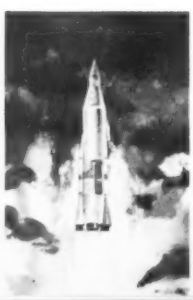


CONVAIR DIVISION OF GENERAL DYNAMICS

USAF's Satellite Test Center Grows

By Russell Hawkes

Sunnyvale, Calif.—Military satellite reconnaissance networks with broader coverage of the Soviet Union and greater security against attack than reconnaissance aircraft will develop out of USAF's 6594th Test Wing and the Discoverer satellites it is testing.

Discoverer satellite series is the means of forging the improved capability. It is doubling as a prototype test program for the versatile Lockheed Agena final stage for space vehicles (AW Feb. 8, p. 19) and as an on-the-job training program for the Satellite Test Wing which will be the nucleus of tactical organizations assigned to combat-ready commands.

Agena is the final stage for Midas, and Samos. Officers at Air Force Ballistic Missile Division, parent command of the Satellite Test Wing, predict that Agena also will be in demand for other space systems.

Lockheed calls Agena a "space truck" to stress the fact that it can guide, propel, orient, supply secondary power, and carry control and communications equipment for a variety of payloads.

Joint Responsibility

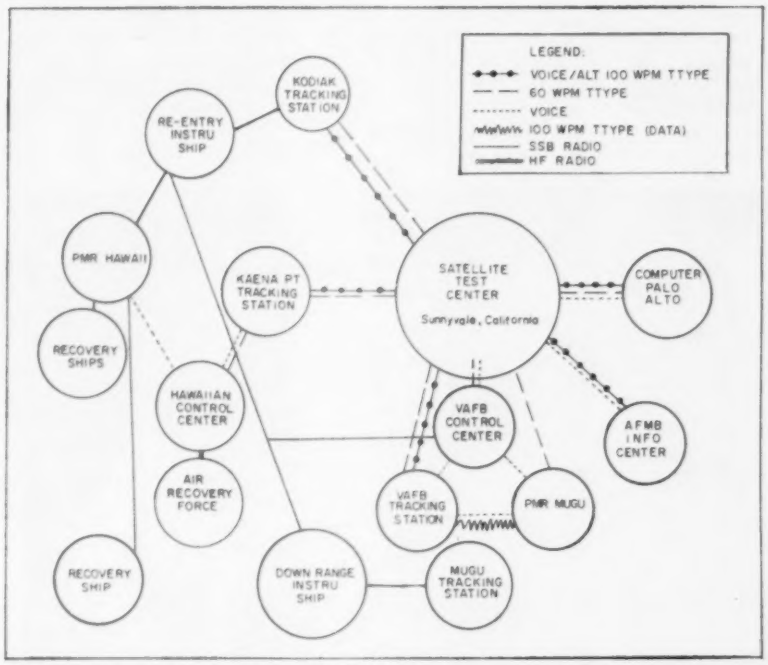
The conduct of each Discoverer and Midas test is the joint responsibility of the 6549th Test Wing and a team of civilian contractors, headed by Lockheed. At present, contractor employes working on a test outnumber Air Force men two to one, but the balance is shifting. By the time the Midas development program ends, every job will be occupied by a member of the test wing. Wing personnel will number about 2,000 at full strength.

The emphasis in the military satellite programs is on complete systems, including ground equipment. The Air Force-contractor team is finding specialized military operating techniques for satellites. These must reflect a set of requirements quite different from those imposed on purely scientific space operations.

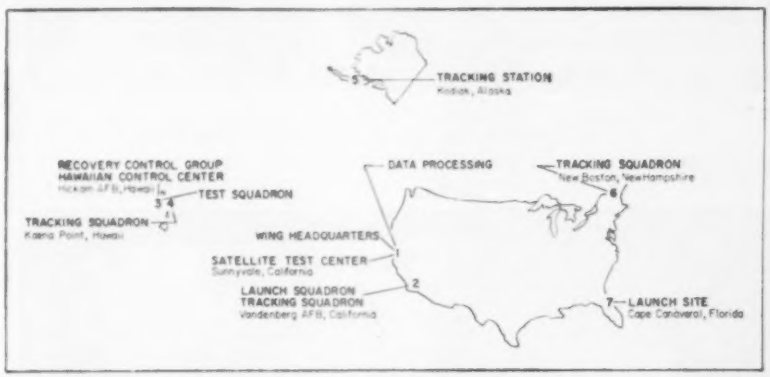
A separate task in the Discoverer series is to develop methods of recovering re-entry bodies.

Test Wing headquarters is the Satellite Test Center at Sunnyvale, Calif., and the core of it is the Satellite Control Room, a command post linked by commercial wire to tracking stations and other installations throughout the Pacific and along the west coast of North America. Direct control of a satellite passes to the Satellite Control Room immediately after a successful launch at Vandenberg AFB to the south. It will also take control of the one remaining Midas to be launched from Cape Canaveral. The Satellite Control Room is providing some support for the successful National Aeronautics and Space Administration Tiros weather satellite program.

During a test the Satellite Control Room is jointly manned by the Satellite Test Wing and Lockheed. Decision-making authority is shared by an Air Force Test Controller and a Lockheed Test Director stationed at the central consoles in the Satellite Control Room. The time available for information-collection, decision-making and the execution of an order is so reduced by satellite velocities that there is no possibility of forming an original plan after recognizing the need for one. Instead, an elaborate System Test Directive considering every known possibility is drawn up before the test. It tells each of the 1,500 men working on a single test what alternatives are available to him in each set of circumstances. The System Test Directive must be completed and approved two months before the test, but is subject to



COMMUNICATIONS network from Satellite Test Center uses radios, high-speed teletypes.



TRACKING squadron located at New Boston, N. H., is newest station in STC complex.

continual discussion and amendment right up to the day of the actual launch itself.

The pressure of time is a necessary condition of military satellite operations. When the military services become dependent on satellites for reconnaissance and intelligence, timely reaction by operational satellite units will be needed as imperatively as quick reaction by ballistic missile squadrons.

Midas satellites will be orbiting over the poles in a steady, carefully spaced stream. The failure of a single one will leave a gap through which an attack could be launched without being detected. Operational units must identify the dead satellite on the first pass after the failure. The replacement satellite must be launched 90 min. later to fill the gap. A hold for technical or other reasons could be dangerous. Ideally, satellite launching vehicles would burn solid or storable liquid propellants to make replacement possible before the completion of a single pass by the dead satellite.

Unlike ballistic missiles, military satellites will be launched in peacetime and must comply with peacetime range safety standards. This can be a serious barrier to timely reaction because the booster must lift off the pad within a very few seconds of a programed time to hit the middle of the gap in the Midas stream. If a civilian airplane, boat or train must be removed from the danger area before launching, it will be another 90 min. before a replacement can be launched from that pad.

It was the pressure of time more than any other factor that caused the Discoverer II capsule to be recovered by the Russians on Spitsbergen rather than by the Americans south of Hawaii (AW May 16, p. 25). The timer in the satellite which starts the capsule separation and re-entry sequence must be set by radio command during the few seconds the satellite is within range of the controlling station. This is done automatically when an operator presses a series of buttons in the appropriate sequence.

In the Discoverer II test, the timer was set by commands from the station at Kodiak, Alaska.

PRACTICE aerial pickup of a data capsule is made by a Fairchild C-119 after the capsule is prepared by the instrumentation ship, Pvt. Joe E. Mann in the Pacific. The plane then returns the capsule to Hickam AFB, Hawaii and capsule is shipped to the Satellite Test Center at Sunnyvale. Below capsule and its container are being reeled into the C-119.

Correct Sequence

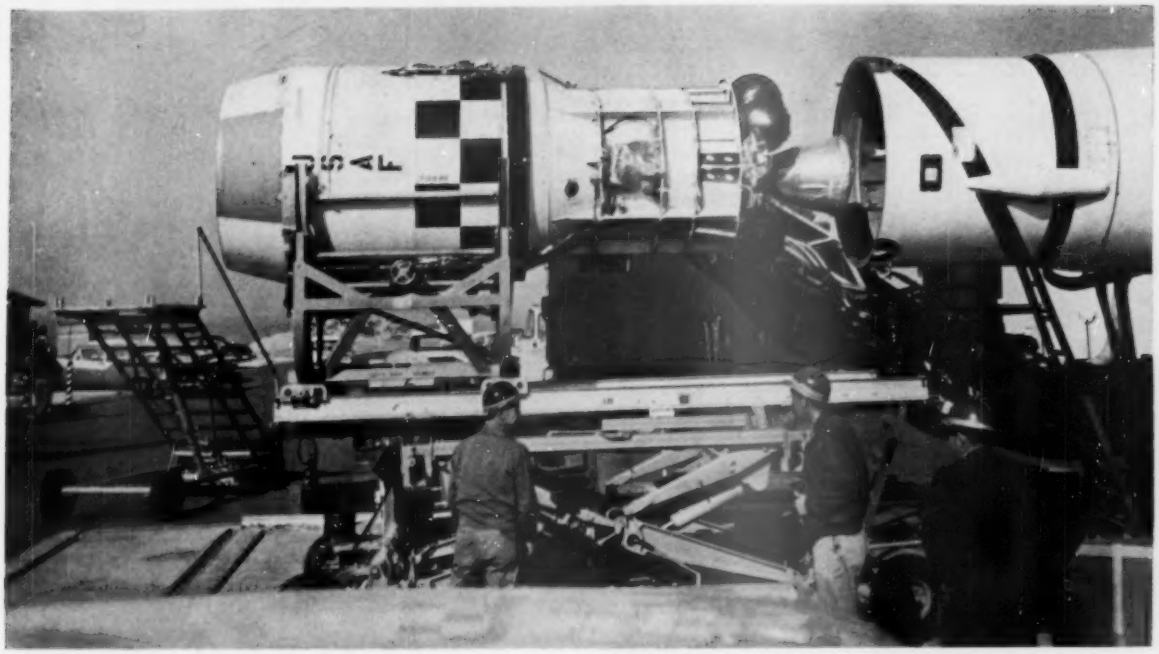
The buttons were pressed in the correct sequence but a monitor showed that the command transmitted was incorrect. This possibility was foreseen by the equipment designers and there is a way to reset the timer, but time was running out on the operator.

Under pressure, he forgot to push the reset button before resending the command signal. The new code pulses added to the earlier ones set the timer for re-entry over Spitsbergen. The timer in the satellite functioned perfectly.

During the Discoverer program, the Test Wing, contractors and supporting elements of the Pacific Missile Range have become progressively more expert at tracking the vehicles during the launch phase and calculating the ephemerides of satellite orbits. This is a vital ability if warning and reconnaissance satellites are to have military value. Their observations can be interpreted correctly only if their precise positions during the observations are known.

Improvements Measured

The improvement can be measured by the increasing accuracy of "acquisition messages" sent to tracking stations by the Satellite Control Room during the first pass. The acquisition message tells each station the predicted time at which it will acquire contact with the satellite and the "look angle" at which tracking antennas should be set to pick up early contact. First acquisition message to Kodiak on Discoverer II was a minute off the actual time of acquisi-



LOCKHEED Agena satellite is mated to a Thor intermediate range ballistic missile booster at Vandenberg AFB, Calif.

tion. By the time of the Discoverer X and XI tests a year later, the error had been cut to one second. Though the Discoverer re-entry capsule was not recovered, Ballistic Missile Division officers say it was, in every other respect, a perfect satellite.

Message Errors

For Samos and Midas, Test Wing officers would like to cut acquisition message error to tenths of a second. The greater accuracy of command guidance used with the Atlas boosters compared with the autopilot guidance in Discoverer's Thor boosters should make this possible. Presently, much of Agena's total impulse is used in compensating for slight inaccuracies in the Thor trajectory. Douglas Aircraft Co. is reported to be working on radio-inertial guidance for later Thor space boosters.

Simultaneous Control

The Satellite Test Center has the capability to control a number of satellites simultaneously. It will soon be handling the Discoverer and Midas programs concurrently and in a few months the Samos program will begin. This multiple satellite capacity is necessary since early warning and reconnaissance systems will need a number of satellites on orbit at the same time. In the military space programs, the emphasis is on systems, for the information gathered by satellites can only be useful if brought back to ground stations, analyzed and translated into a comprehensible presentation that can be used by defensive and retaliatory forces as a basis for decisions.

The systems needed for scientific exploration of space can, to some extent, be extemporized for each mission because they are not continuously repeated, time is not so pressing and the caliber of the people running them can do much to make up for the shortcomings of non-human parts of the system.

The importance and repetitive nature of military missions impose different requirements:

- **Boosters must be relatively** inexpensive or recoverable.
- **Control and information handling** elements of the system must be manned

Samos Development Accelerated

Air Force's Samos advanced reconnaissance (optical) system probably will get accelerated development support as a legally defensible "seeing-eye satellite," as a result of the critical international tension generated by the flight of the U-2 through the airspace of the Soviet Union.

The increasing procession of satellites, both U.S. and Soviet, some of which have incorporated camera capability, has begun to underscore the futility of "closed skies." If satellites are to be validated by international law—and no international protest has been raised so far—the question of "restricted space" above any nation becomes academic.

Long funded on a "shoestring" basis, Samos only recently has been given strong support and likely will get even more from a bigger dip into WS-117L funds for Discoverer, Midas and Samos.

Operational status may be achieved in 1961—even before Midas—if the support and development programs are continued on a high level. The system's optics have been ready for a considerable time.

Launched from Navy's Pt. Arguello pad, Samos will orbit in a north-south trajectory to cover the entire earth, which will rotate beneath its path. Estimates are that eight to 12 of the reconnaissance satellites in simultaneous orbits will give adequate, continuous surveillance of any territorial area.

From an operational altitude of between 300 and 500 mi., the satellite's high resolution camera will film ground installations for television-relay, on command, to a data-gathering and control post. Provision probably also will be made to eject and retrieve a photographic film.

Replacement satellites will be required, like troops ready to plug gaps in a combat line. These spares, poised on top of Atlas-Agena vehicles, will have to be launched and injected into orbit with extreme precision to take the place of a "dead" satellite which, through equipment malfunction, sends back no intelligence.

A PROGRESS REPORT FROM REPUBLIC STEEL...

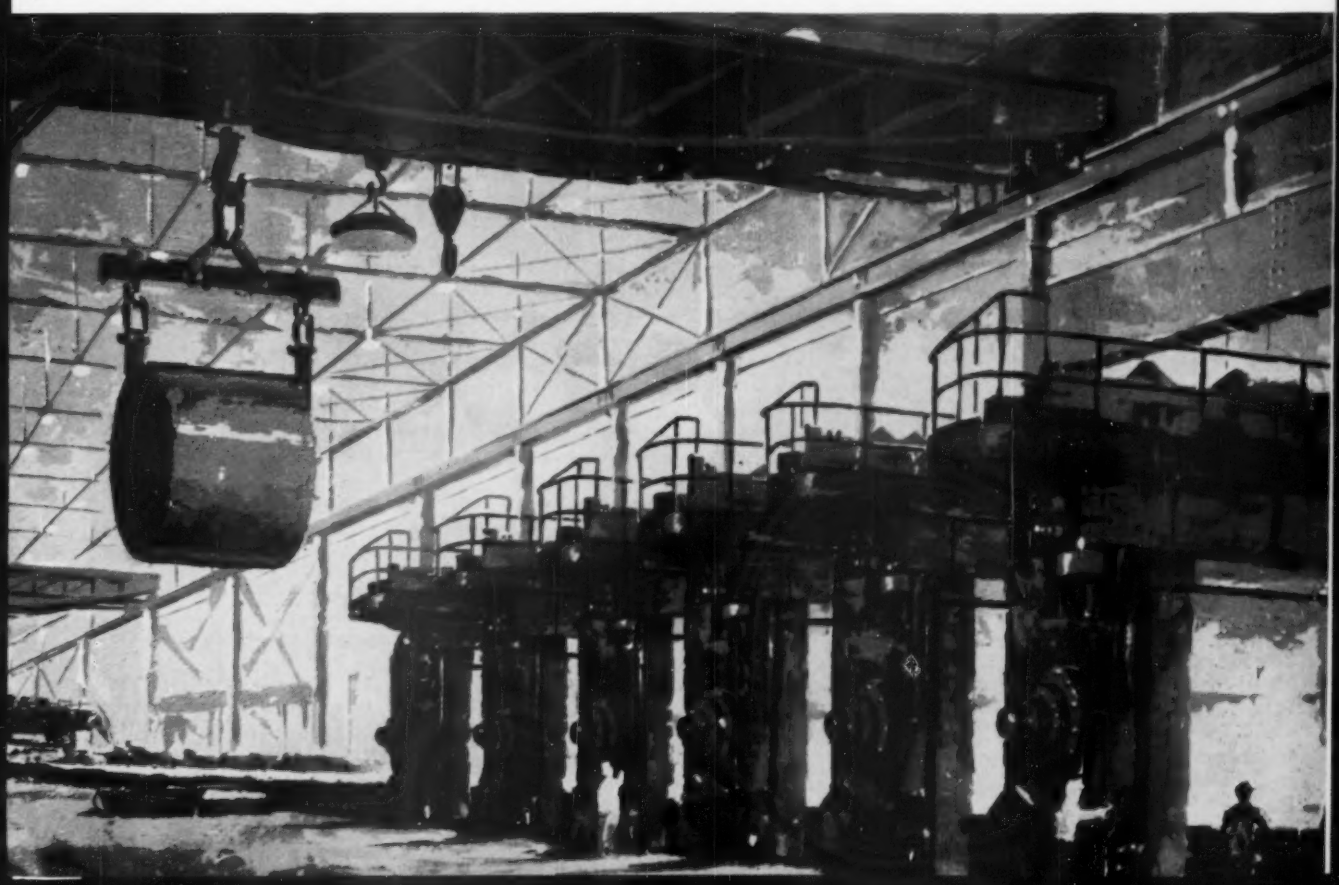
New 56-inch hot mill to roll special grades of high-performance stainless

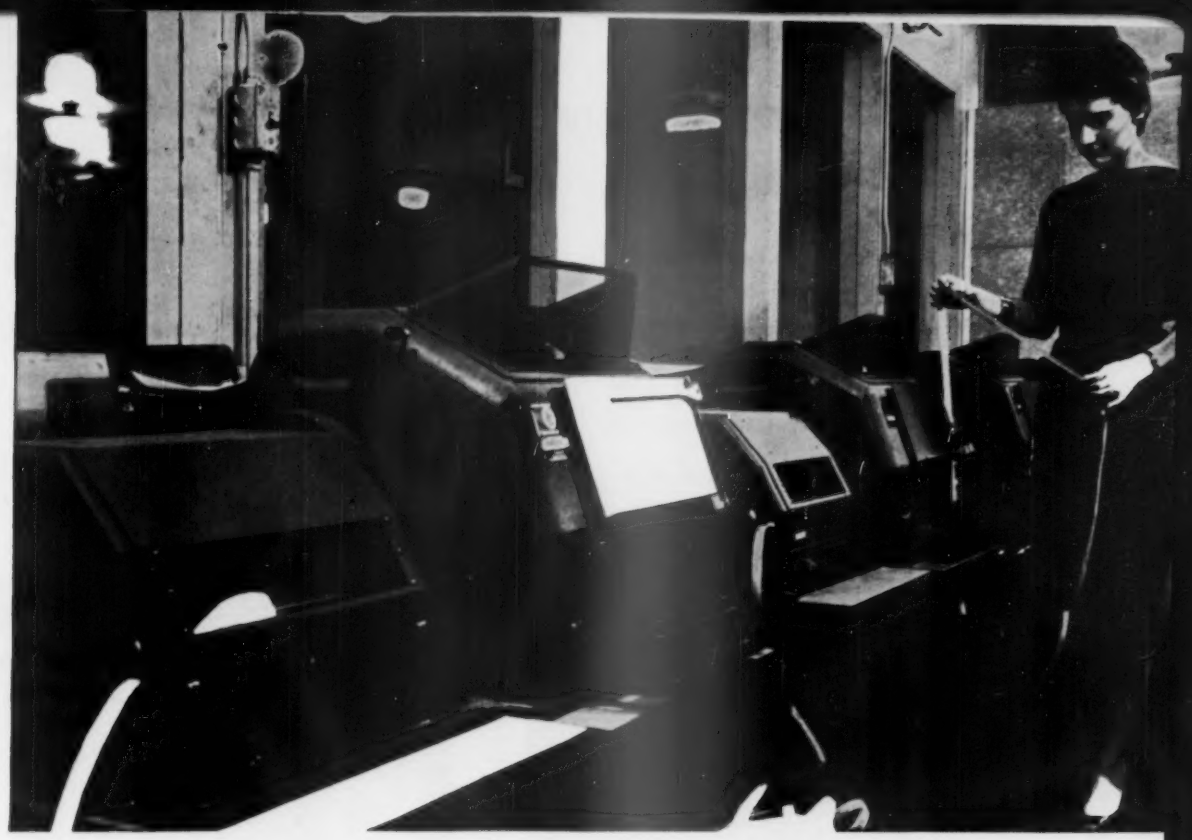
The new 56″ hot rolling mill in Warren, Ohio—first major project in a new capital improvement program—is of particular significance to designers, engineers, and metallurgists involved in aircraft or missile work. To be completed late in 1960, this new facility is geared to roll special grades of high strength stainless steel now being developed.

Many such improvements and additions by Republic promise major breakthroughs in quality . . . plus the vastly increased range of sizes, types, gages, finishes, and other specifications that will be required.

This is what Republic is doing now to help you—in the decade ahead—improve design, reduce costs, assure a level of performance currently unobtainable.

This mill has additional built-in power to hot roll stainless and other special alloys at proper temperatures and provide industry with large coils which could effect economy in production.





Automated order processing system Saves you days...Saves you dollars!

As a customer of Republic, you enjoy speed and efficiency made possible by a network of tele-typewriters linking district sales offices to centrally-located service centers.

Your inquiry is transmitted to such a center (via the Cleveland switching center) in a matter of minutes. Here, teams composed of metallurgists, sales order experts, and mill schedule specialists take over. They (1) check specifications against mill schedules, (2) confirm your order, and (3) relay it to the proper mill for scheduling and processing.

In a matter of hours, your order is placed on a mill. Your purchasing department is alerted to incoming material the morning after shipment is made. And, your specifications are filed on paper tapes to cut service time on repeat orders.

Soon to include an automatic system of scheduling and processing within each Republic plant, this program is another example of Republic's continuing effort to improve service to you . . . the customer.

REPUBLIC STEEL

Cleveland 1, Ohio

World's Widest Range of Standard Steels and Steel Products

REPUBLIC OFFERS YOU...

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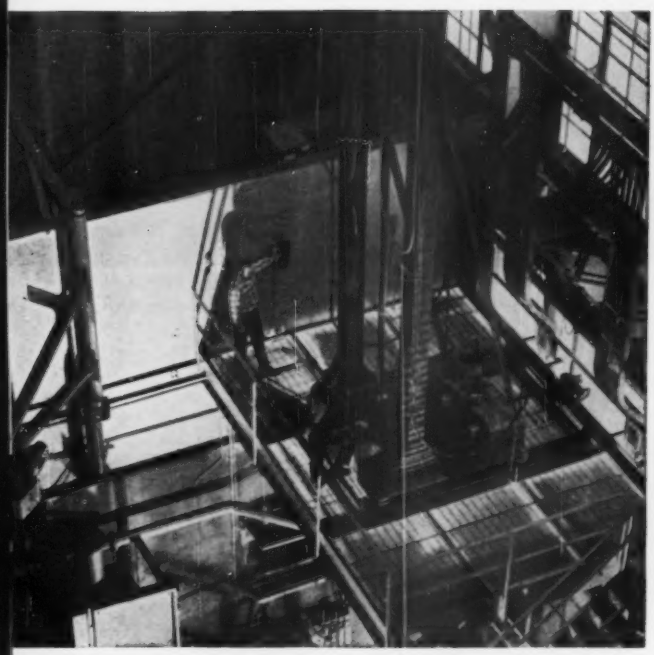

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and operating without interruption. • **High reliability** must be obtained to avoid the cost of many replacements and ensure availability in time of need. • **Components of the system** must be standardized and largely automatic for use by non-scientists.

The 6594th Test Wing was formed only six months ago. When Midas and Samos become operational systems, it will be necessary to fit the competence developed by the wing into combat-ready Air Force commands needing the satellite capability. The date and the manner in which this will be done have not yet been chosen because funding is too uncertain to justify firm plans.

The Test Wing includes the launch squadron at Vandenberg AFB and a Data Processing Squadron at Offutt AFB, Neb. Data from the Discoverer program is reduced by the computers of Lockheed Scientific Research Laboratory at Palo Alto, Calif. The tracking stations at Kodiak, Vandenberg and Kaena Pt., Hawaii, are jointly manned by the wing and civilian contractors. Employes of Lockheed and Philco still outnumber Air Force men by a good margin, but the balance is shifting.

The 6593rd Test Squadron, trained to recover descending Discoverer capsules in midair, is a purely military organization, as are other flight operations in the program.

A northeastern tracking station is being set up at New Boston, N. H., mainly to get ready for Midas. Logically, a chain of Midas tracking sites should stretch across the northern approaches to this continent. The New Boston station could well be the first of these. One more Midas launch is scheduled to take place at Cape Canaveral before the program moves to its own pads at Naval Missile Facility, Pt. Arguello, adjacent to Vandenberg AFB.

The Arguello pads were not ready for the start of the program, but will go into operation this fall. The polar orbit intended for Midas cannot be entered safely from Canaveral. Arguello is a facility of the Navy-operated Pacific Missile Range (AW May 9, p. 81).

Officers of the Satellite Test Wing report favorably on the support given to the Discoverer program by Pacific Missile Range. Two instrumentation ships, two capsule recovery ships and two Lockheed WV-2 early warning aircraft are placed on station by Pacific Missile Range at Satellite Test Center direction. A Discoverer tracking station is also operated at Pacific Missile Range headquarters, Pt. Mugu.

AIR FORCE test controllers at the Sunnyvale Satellite Test Control Center monitor data displayed on Vugraph screens during a Discoverer operation.

Instrumentation Ships

The instrumentation ships are incapable of tracking the satellite because there was not enough money available to give them the necessary Polaris-quality navigation equipment. They carry telemetry receivers and are stationed under the points at which special sequences of events in the satellite must be verified. The Kings County, a converted landing ship, is stationed about 1,000 mi. downrange from Vandenberg to report the functioning of the Agena final stage in achieving injection velocity of 26,050 fps. and turning itself end-over-end to prepare for the re-entry sequence schedules 10 or 20 passes later. Telemetry vans are lashed to the deck of King County to increase its capabilities.

The other instrumentation ship, Private Joe E. Mann, is stationed between Kodiak and Hawaii to gather telemetered information on satellite performance of the re-entry sequence. Telemetry equipment on both ships is operated by Lockheed employes, who use single sideband radio to communicate directly with each other, Vandenberg and Mugu. Messages for the STC are relayed by Kodiak or Vandenberg over land lines.

The Satellite Test Wing and Pacific Missile Range both plan to equip aircraft to do some of the telemetry receiving jobs. They will be less expensive than ships and have been used successfully by Atlantic Missile Range. The wing will use the Lockheed C-130. One C-130 has already been used to bring back magnetic tape reels of data from the Kings County, snatching the pouch from a pole raised over the ship. Aircraft also have been used by the Test Wing to carry spare parts to the ship. Other C-130s will replace the nine Fairchild C-119s used by the recovery squadron based at Hickam AFB, Hawaii.

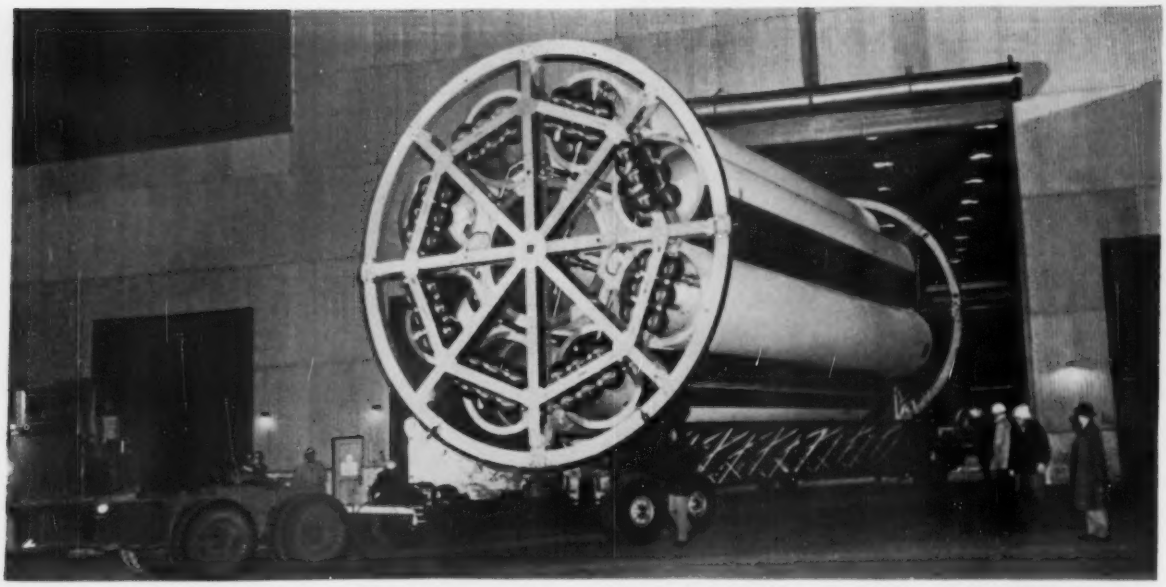
The two Lockheed WV-2s and four Lockheed RC-121 airborne early warning and control planes from McClellan AFB, staging through Hickam, are supposed to vector the recovery aircraft to intercept the descending Discoverer capsule. They are stationed outside the perimeter of Blossom Area, where the capule is intended to re-enter.

One carries the airborne commander of the recovery force. Recovery ships, backing up the airplanes, carry helicopters and frogmen.

Midas Orbit

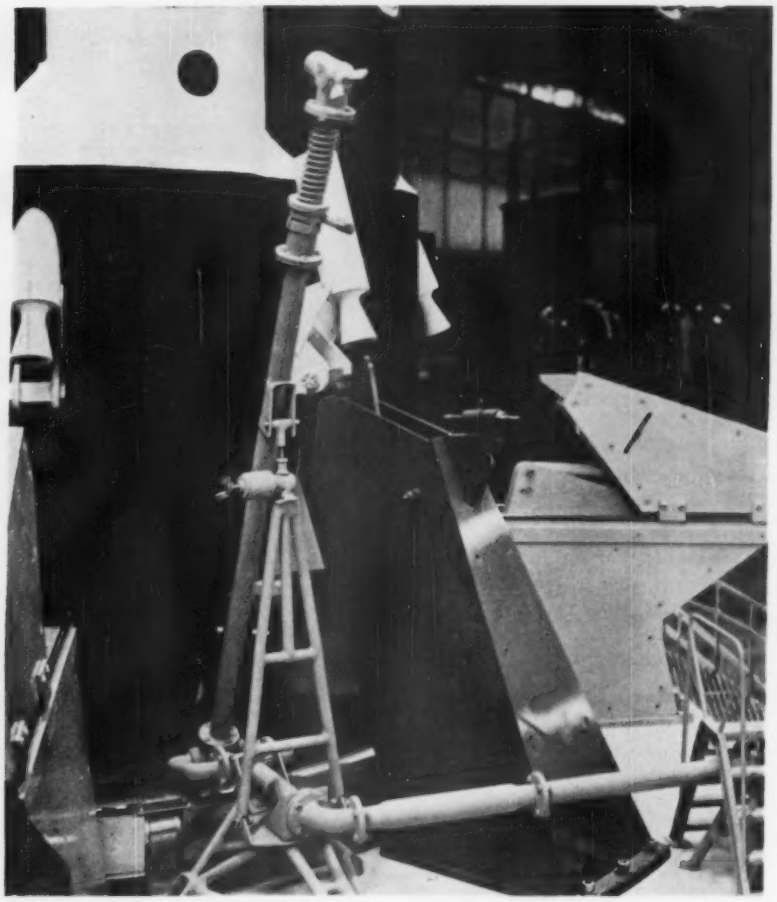
Air Force's Midas satellite, a missile defense alarm system, will orbit the earth in a north-south 300- to 500-mi. altitude path, like its photographic reconnaissance counterpart Samos, using infrared sensors to spot the heat swath a hostile ICBM generates in launch or flight, translating this detection for instantaneous transmission to alert a command and control post. The system forms the basis for an operational refinement combining infrared sensing with counter-weapon launch capability or ejection of obstruction material in space.

Like Samos, a network of at least eight to 12 of the Midas satellites will be required for full-time early warning capability, with backups to fill in for orbiting satellite non-functioning instrumentation. Targeted for operational status after the beginning of 1961, Midas will be launched by the Atlas-Agena vehicle. First Midas vehicle's launch sequence in February from Cape Canaveral, Fla., was not successful. The second experimental vehicle was launched last week. Third launch will be from Vandenberg AFB, for north-south orbiting, or from Pt. Arguello, if the operational pad there is ready.



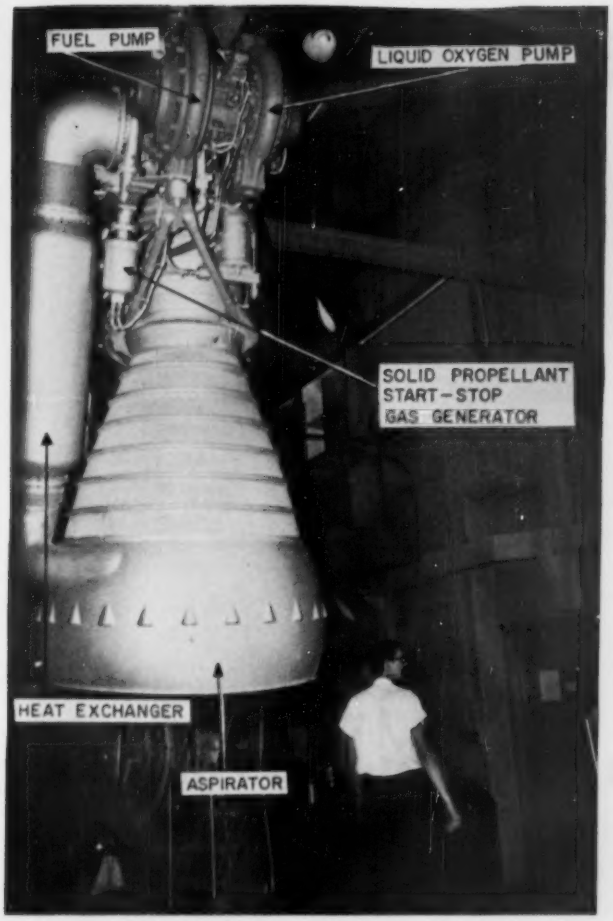
Static test model of Saturn booster is trucked out of its assembly area at Huntsville, Ala. Ten other boosters will be built during the development program, and these will all be flight models. First flight test booster is nearing completion. Boosters will remain on the trailer during their approximately 17-day barge trip from Huntsville to launch site at Cape Canaveral, Fla.

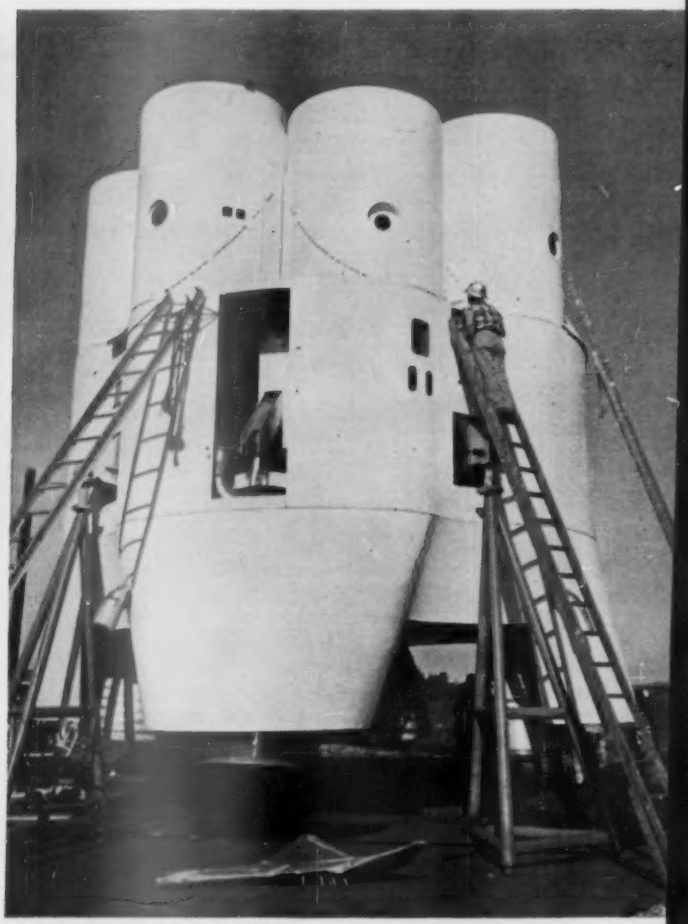
Saturn System Incorporates Unique Design Details



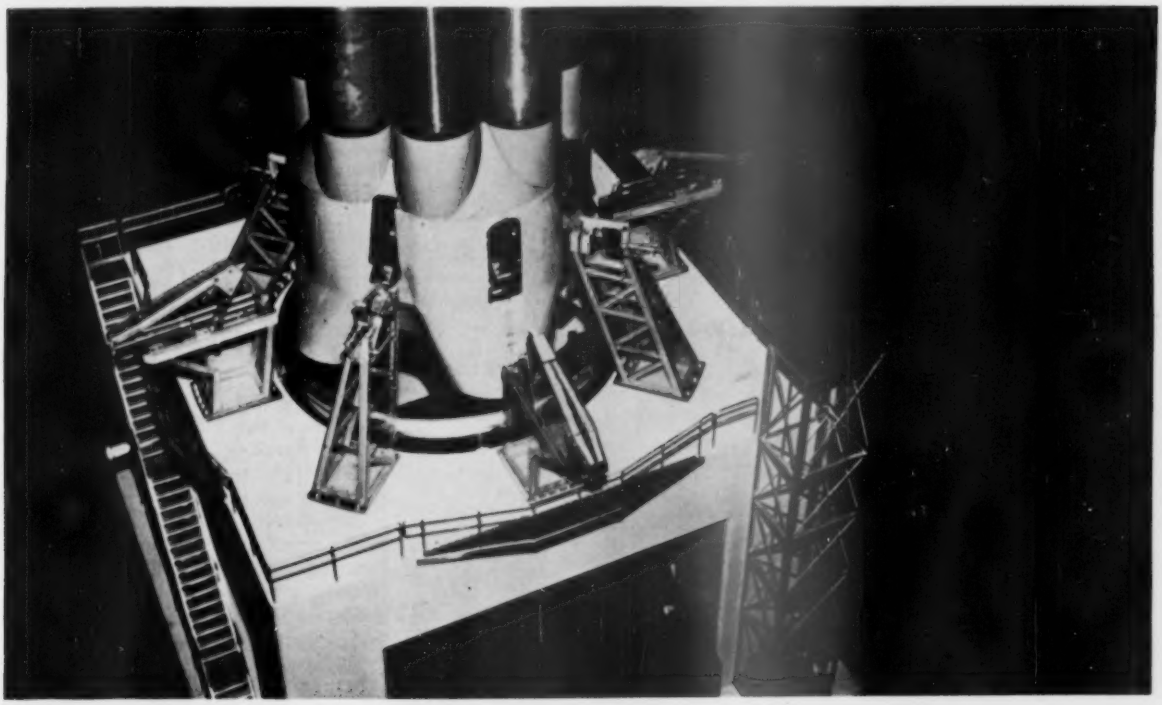
Horizontally-moving hold-down device in background has four clamps which disengage and, as they travel back from Saturn, actuate the flip-back hold-down clamp in foreground.

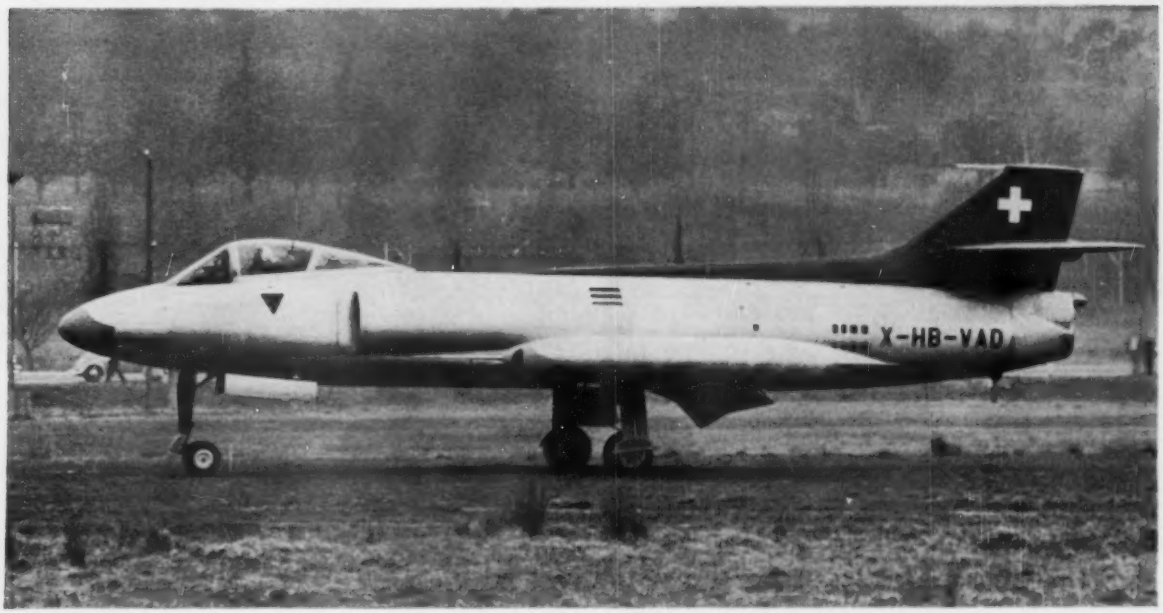
Saturn's gimbaling Rocketdyne H-1 control engines (left at top of opposite page) differ from the four stationary engines in the center of the cluster only in that they have an aspirator to exhaust the fuel-rich gases from the turbopump gas generator. These gases from the stationary engines are piped outside the skirt and exhausted in a high-velocity flow region. Heat exchanger of the aspirator is used to improve the efficiency of the propellant tank pressurization system by heating the cold gas from the storage bottles as it is piped into the tanks. Solid propellant start and stop system for the H-1 requires one wire to trigger each of these sequences and one neutral wire. Solid propellant charges are used to generate gas that will either start or stop the turbine driving the turbopumps. This simplified system is expected to greatly increase reliability of the Saturn booster. Start systems on rocket engines now operational usually have a complicated series of pressure sensors, relays and electro-pneumatic valves to bring the engine up to full power. When the chamber pressure of the Saturn engines indicates all of them are developing about 90% of rated thrust the release of the hold-down mechanism (left) begins automatically. Thrust buildup with the H-1 engines is so rapid that they will be at almost full power by the time the release sequence is completed. The hold-down system consists of four clamps which are disengaged by moving back horizontally and four that rotate and flip back. Skirt indentation between outboard gimbaling control engines at base of Saturn booster (right at top of opposite page) provides a boat-tail effect and permits a strong flow of air to pass around the four fixed engines.





Mockup of Rocketdyne H-1 engine for Saturn at left is shown in the configuration used for gimbaling the control engines. Full-scale mockup of Saturn base section and engine assembly is at right. Saturn launch stand model below shows hold-down clamps.





SWISS P.16 Mk. 3 strike fighter lines up on runway extension at Altenrhein prior to takeoff. Fuselage is 46.9 ft. long.

P.16 Sales Sought Outside Switzerland

By David A. Anderton

P.16 has leading edge flaps, partial-span trailing edge flaps and drooped ailerons.

Altenrhein—Low-level ground-attack P.16 Mk. 3 strike fighter, designed specifically to a tough Swiss requirement for army support, is a technically good airplane that got caught in political cross-fire.

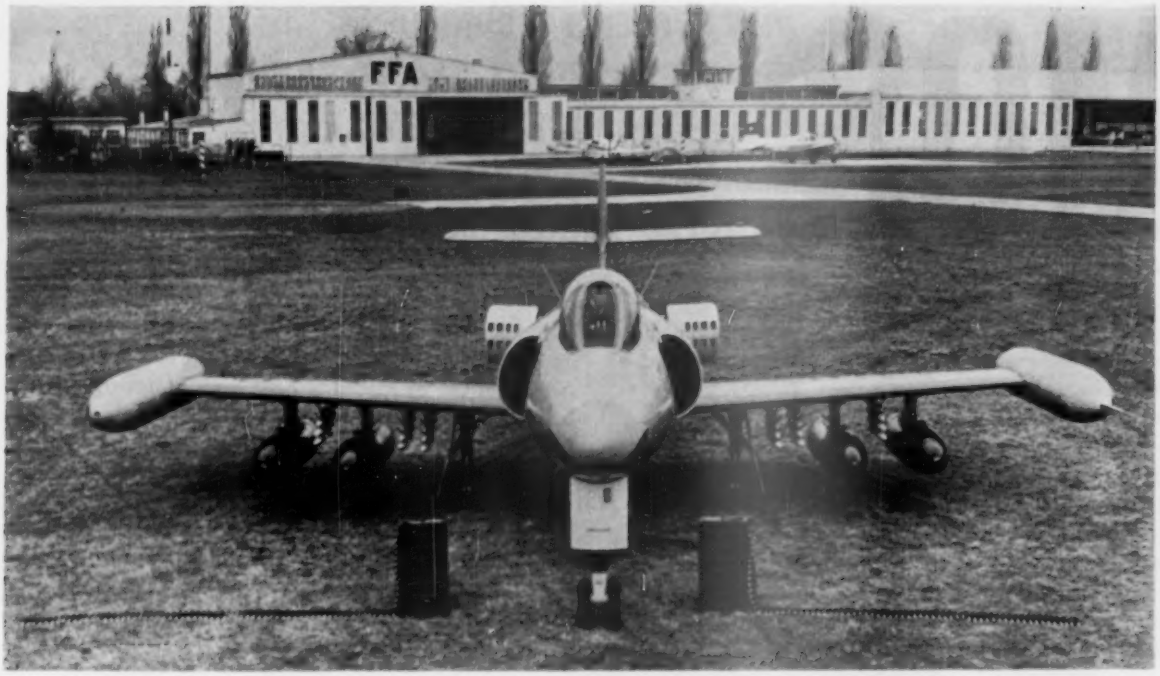
Designed and developed by engineering and manufacturing teams at Flug- und Fahrzeugwerke AG, Altenrhein, the P.16 now is being offered for sale or license-production outside Switzerland, either in its present form or with design developments including a new powerplant.

Present engine is the Bristol Siddeley Sa. 7 Sapphire turbojet, rated at 11,000 lb. sea-level static thrust. Development of the P.16 would be powered with a Rolls-Royce RB.146 rated at 13,200 lb. thrust as an alternate. Performance would be improved between 20 and 35% in takeoff, climb and acceleration.

Both Swiss and foreign pilots who have flown the P.16 report favorably on its handling characteristics, low-speed performance, stability as a gun platform, and short-field capabilities.

In its present form, it can carry nearly 6,000 lb. of armament out of mountain airfields with runway to spare, hammer a number of targets, turn in the air on a small radius and head home at 700-mph. speeds near the ground.

Two years ago, the plane was ordered into production by the Swiss govern-



P.16 ARMAMENT shown consists of four napalm bombs, 24 air-to-ground rockets and ammunition for two 30-mm. cannon.

ment as a replacement for the country's aging de Havilland Vampires and Venoms. Within one week after the order was placed, the third prototype airplane was lost when the pilot ejected safely in a landing approach following hydraulic system trouble. The new order was suspended until after the official investigation of the accident, and two months later was canceled (AW June 9, 1958, p. 25).

Official reason for the cancellation was that the hydraulic system was faulty, would have to be completely redesigned and would delay production of the airplane to a point where the order would not be worthwhile. But unofficial observers believed then—and still do—that the incident was a convenient excuse to dump an airplane for political reasons rather than on any sound technical ground.

Cancellation Remained

In spite of the company's protests that the hydraulic system was sound, and the results of an investigation made by an impartial team of British engineers from Royal Aircraft Establishment-Farnborough which cleared the system and the company of blame, the cancellation stuck. Studies were begun to determine the best airplane available outside Switzerland for purchase or license production.

Two years later, the Swiss air force technicians are still studying the problem, and still must make a decision on what will replace the even-older Vampires and Venoms. Costs have risen, delivery dates have stretched, and Mach 2 is the magic number for military airplanes.

But against the background of specific Swiss requirements, the P.16 still seems this country's best bet to many of the operational military pilots here.

The P.16 Mk. 3 version is a single-place, single-jet airplane in the 21,000 lb. weight category, with maximum speed just under 700 mph. At normal weights, it can take off in 1,500 ft., and land in 1,000 ft. on a sea-level field. At overload weights up to about 25,000 lb., it can take off and land on a mountain airport nearly 7,000 ft. above sea level using about one mile of runway.

The airplane will not spin. It can be flown under control in a fully-stalled attitude, at vertical descent rates up to 120 fps. It has never shown stalled wing drop, either in high-speed or landing configuration, straight and level, or in a tight turn.

P.16 Mk. 3 Strike Fighter

Specifications

Over-all length	46.9 ft.
Wingspan	36.6 ft.
Height	14.0 ft.
Wing area	323 sq. ft.
Sweep at quarter-chord	16 deg.
Internal fuel	650 gal.
Maximum fuel, (including auxiliary tanks)	890 gal.
Empty weight	15,500 lb.
Normal gross weight	20,475 lb.
Overload gross weight	25,800 lb.
Maximum landing weight	18,500 lb.

Hit Averages

Hit averages as high as 80% have been obtained on a 16 sq. ft. target at distances up to 5,000 ft., and pilots for the gunnery and rocket firing runs were loud in their praise as a stable platform.

It has been flown through a company flight-test program by a Swiss reserve military pilot. He had a total of 600 hr. flying time, and began the test routine after five familiarization flights from a 4,000-ft. runway.

Growth has been designed into the airplane. Zero-launch or rocket-assisted takeoff capabilities, arresting gear, increased brake chute size and increased internal fuel capacity could be installed as modifications to the existing airplanes. During tooling for production, additional design developments could be accommodated: the RB.146, afterburner installation, liquid-propellant rocket engines, or a two-seat configuration.

Design Requirement

Structural design of the airplane was based on British Design Requirement AP 970 for military aircraft. The company used some American or French design criteria when they were tougher than those of AP 970. Critical design condition for the stressmen was a speed of Mach 1 at an altitude of 7,200 ft. with a load factor of 8.5. Ultimate

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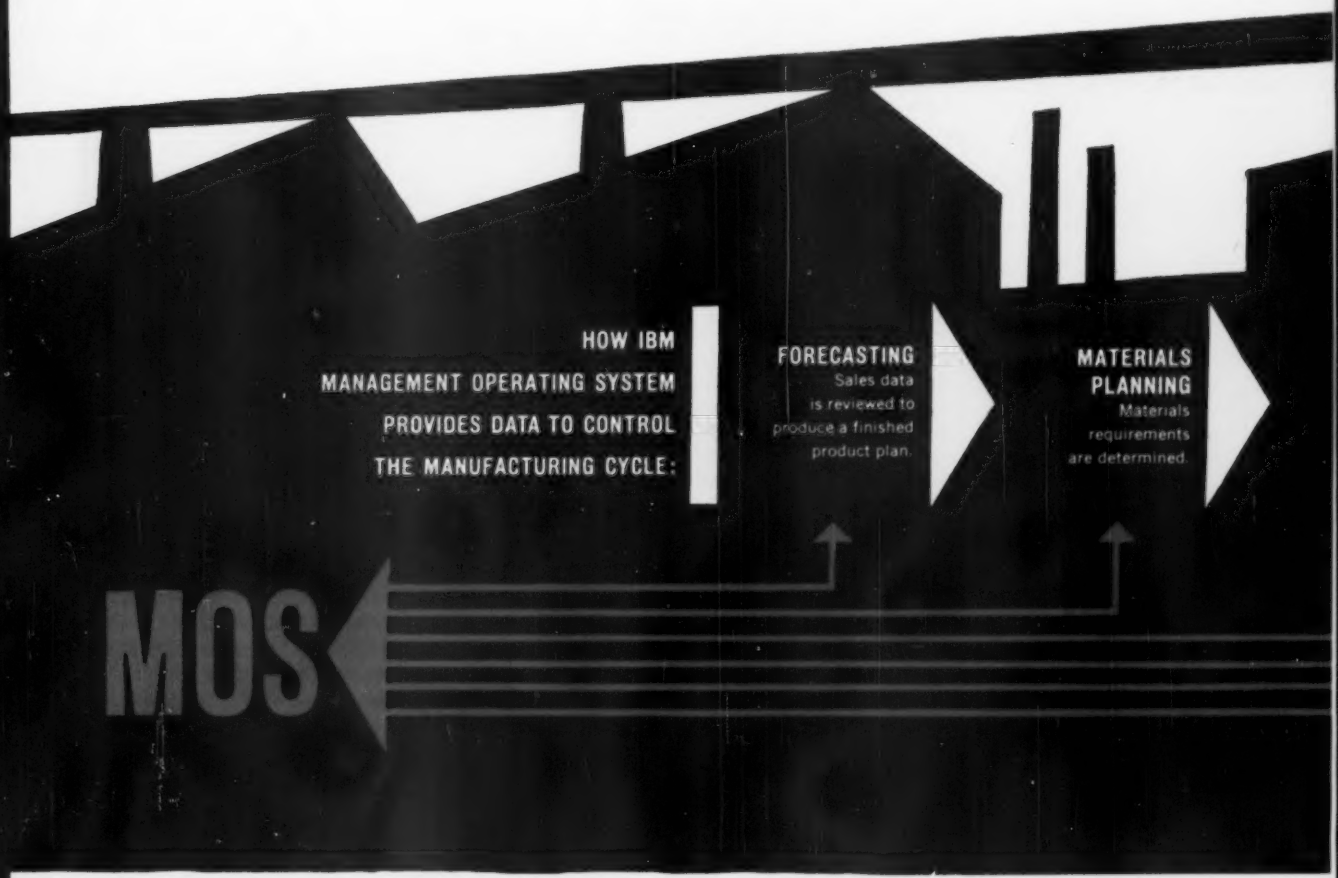
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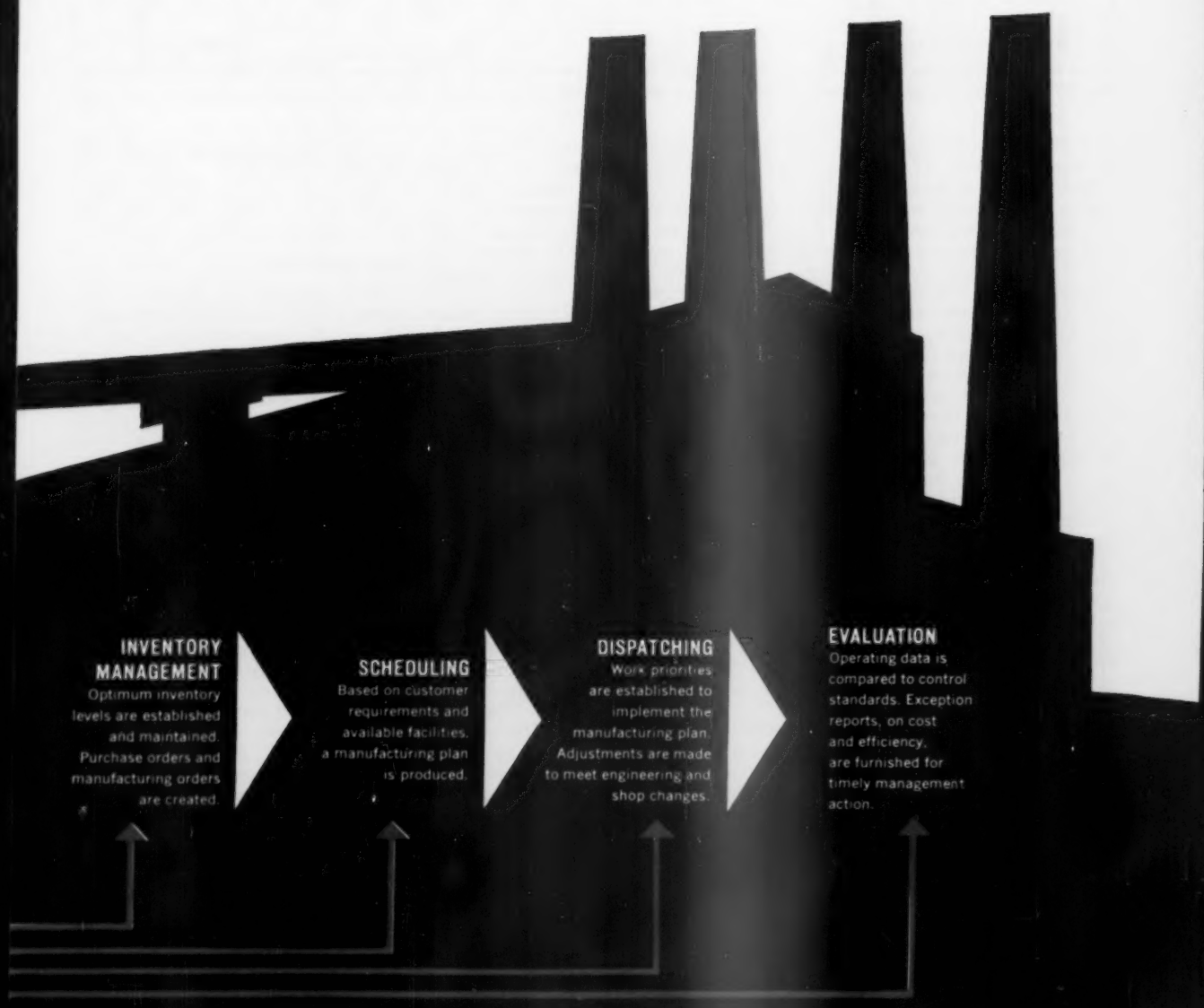
MATERIALS PLANNING
Materials requirements are determined.
MOS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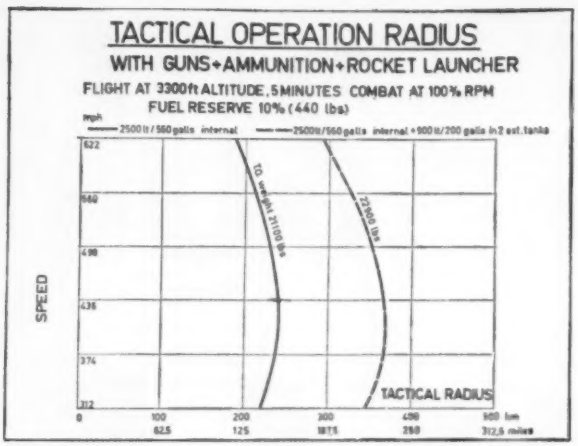
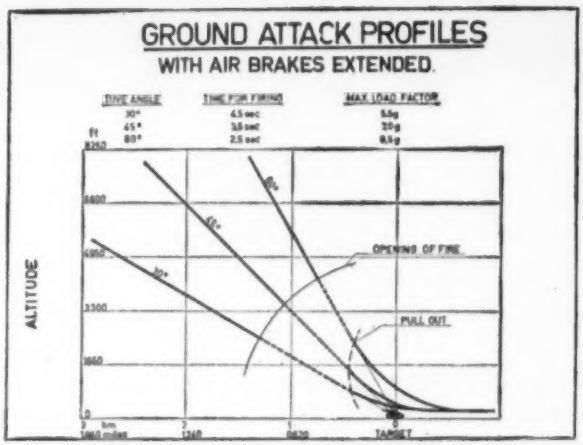




SWISS P.16's tactical radius at different takeoff weights is plotted at left; ground attack against a tank is plotted at right.

load factors are 12.75g positive and 9g negative.

After the loss of the third prototype and the investigation and cancellation that followed, Defense Minister Paul Chaudet, now president of Switzerland, publicly accused the company of not following design requirements, not meeting British structural criteria and not notifying military technicians of changes in the design.

FFA officially denied these charges (AW July 7, 1958, p. 89), said it had informed the technical section of changes, and then asked for a full-scale investigation of the whole affair. The upshot was that the British Ministry of Supply was asked to send a group of specialists from RAE-Farnborough to make an investigation.

The British team went through the entire story of the accident, and their final report cleared the company of any technical blame in meeting design requirements for the hydraulic system. FFA engineers built a full-scale hydraulic system test rig and, after hundreds of cycling tests and minute investigations of the available wreckage, pieced together the probable sequence of events that led to the loss of the airplane.

Physical Phenomenon

It boiled down to one material failure and two human errors. The odds of these occurring in sequence were very low. Coupled with these was a physical phenomenon which had not been completely understood before the P.16 crash, either by Swiss engineers working with the best available data, or by the British, from whom much of the hydraulic system data came.

The material failure was in a coupling on the downstream side of the main hydraulic system supply tank. Its failure allowed air to be pumped into the system, and the hydraulic fluid absorbed much more of that air than any earlier data had indicated. Foaming of hydraulic oils is and was a known phenomenon, but the percentage of foaming was indicated as reasonably low by all technical information available to the Swiss engineers. This was not the case in fact; the percentage of foaming was very high.

The first human error occurred in the ground crew, which didn't realize that the hydraulic tank was full of foam instead of liquid. The crew could see the level of what was thought to be fluid, well above the visual inspection window on the side of the tank, and the crew assumed that it was better for the tank to be over-filled than under-filled. The high level was not reported, and so there was mostly foam in the system after several flights with the cracked coupling.

Final Flight

On the final flight, the hydraulic system pressure finally dropped below the cutoff point because of the foaming. It happened during the final approach to the field. Normally if there had been a hydraulic system failure, the pilot could have controlled the airplane manually if the airplane had been trimmed for the particular flight configuration.

But that was the second human error. The pilot had been making high-speed runs and the airplane was trimmed to be nose-heavy.

He had not retrimmed the airplane for the approach, and was holding the attitude of the P.16 with the stick deflected.

When the hydraulic system pressure dropped below the normal value due to foaming, and cut out both the main and the standby system, putting the airplane on manual control, the pilot could not hold the stick force. The stick was yanked forward to full deflection out of his hands. Left with no time to trim and not enough strength to fly the airplane manually, the pilot ejected safely and the P.16 crashed into the lake off the end of the runway.

That freak accident, with its triple-linked chain of errors, spelled the end of the P.16 for the Swiss.

New Company

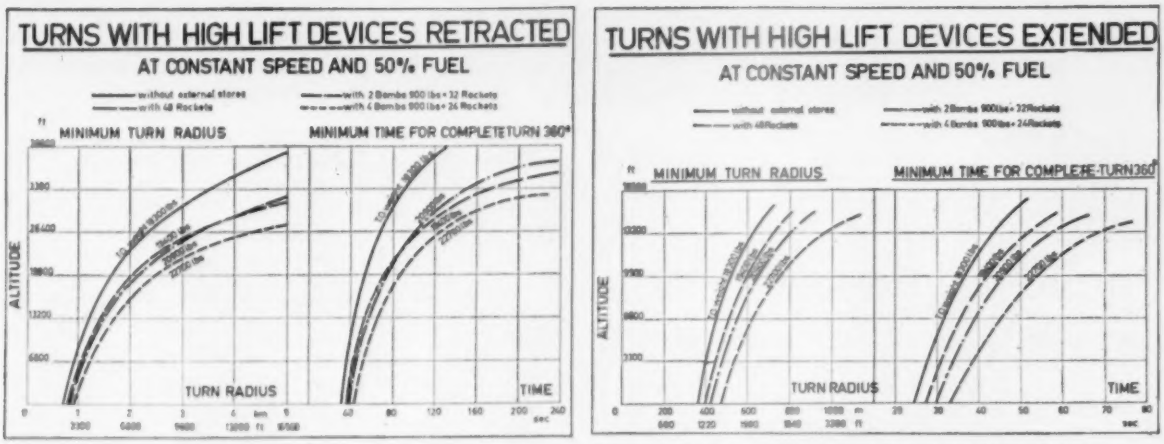
With government support withdrawn, a dark cloud of suspicion hanging over the company, FFA's aircraft future looked very dim. The engineers believed in the airplane, and felt that they had to clear it and themselves of the charges made against it.

They formed a new company, completely independent of FFA financially, called AG. für Flugzeugunternehmungen Altenrhein, with the specific objective of completing the flight test and development of the airplane (AW Sept. 7, 1959, p. 29). The program was started by reserve military pilot John Bardill after training of five flights in the fourth prototype airplane. Bardill, like most of his Swiss compatriots, is not a professional military pilot, and serves six weeks per year with the Swiss air force, getting a maximum of about 70 hr. flight time per year in military jets.

Part of Bardill's program was a series of flights on manual power only, in high-speed, low-speed and turning flight, and in the landing configuration. He reported no difficulties in flying the airplane under full manual control under any of the test conditions.

Since then, the P. 16 has been flown by other pilots, including William P. Lear, Jr., vice president in charge of Lear's European operations. Lear, an ex-military pilot with about 1,000 hr. jet time, mostly in fighter-bombers, made the flight primarily to check out his company's equipment in the P. 16. During his flights, he reached the highest Mach number (1.06) and the highest indicated airspeed near the ground (745 mph.) attained during the airplane's test program.

"What really impressed me," he


TURNS WITH HIGH LIFT DEVICES RETRACTED
AT CONSTANT SPEED AND 50% FUEL
without external stores
with 48 Rockets
with 2 Bombs 900 lbs + 32 Rockets
with 4 Bombs 900 lbs + 24 Rockets
MINIMUM TURN RADIUS
MINIMUM TIME FOR COMPLETE TURN 360°
ALTITUDE
TURN RADIUS
TIME
TURNS WITH HIGH LIFT DEVICES EXTENDED
AT CONSTANT SPEED AND 50% FUEL
MINIMUM TURN RADIUS
MINIMUM TIME FOR COMPLETE TURN 360°
ALTITUDE
TURN RADIUS
TIME

HIGH LIFT DEVICES on the P.16 include Fowler type trailing edge flaps and full-span leading edge flaps with 120-deg. deflection.

said, "was to be able to check out in a new jet airplane on a 3,600-ft. runway." The P. 16 never needed more than 2,000 ft. of the runway for takeoff, or more than 1,500 for landing, he said. This is parallel experience to that of other pilots who have flown the P. 16.

Pilots Impressed

This short-field performance, coupled with the P. 16's stability as a gun platform and its turning capability, have impressed both pilots and observers. These capabilities were one of the major design goals of the engineering design team headed by Dr. Hans L. Studer.

Major aerodynamic feature of the P. 16 is its wing, a design compromise aimed at getting the best possible high-speed and low-speed characteristics combined with great structural strength. These combined considerations dictated the final choice of wing layout: aspect ratio of 4.15, constant thickness ratio of 8%, full-span leading edge and trailing-edge flaps, permanent tip tanks giving an end-plate effect, no internal fuel, no cutouts, and an ultimate load factor of 12.75.

These characteristics added up to remarkable low-speed turning performance, and very short takeoff and landing runs. Practical lift coefficients in landing configuration approach a value of two.

Fowler Flaps

Trailing edge flaps are Fowler type, spanning about half the wing, and running on eight curved rails to a maximum deflection of 45 deg. Flap span extends right across the fuselage belly.

Additional trailing-edge flap comes from drooping the ailerons through 18 deg., simultaneously dropping their hinge line to increase the slot gap.

Full-span leading edge flap with a deflection of 120 deg. is fitted to the P. 16. This flap is a constant-chord section of the wing undersurface, made of a magnesium-zirconium casting, and deflected down and forward to the 120-deg. position by four hydraulic jacks.

First proposal for such flaps—distinct from slats, slots and droop-snoots—was made during World War II by German aerodynamicist Dr. Krüger of Gottingen University. FFA's studies of the flap began in 1947 on a theoretical and wind-tunnel test level, and were incorporated into the P. 16 design. They were first flown on a prototype airplane in April, 1955, in what the Swiss say was the first actual use of the leading edge flap on a full-scale airplane.

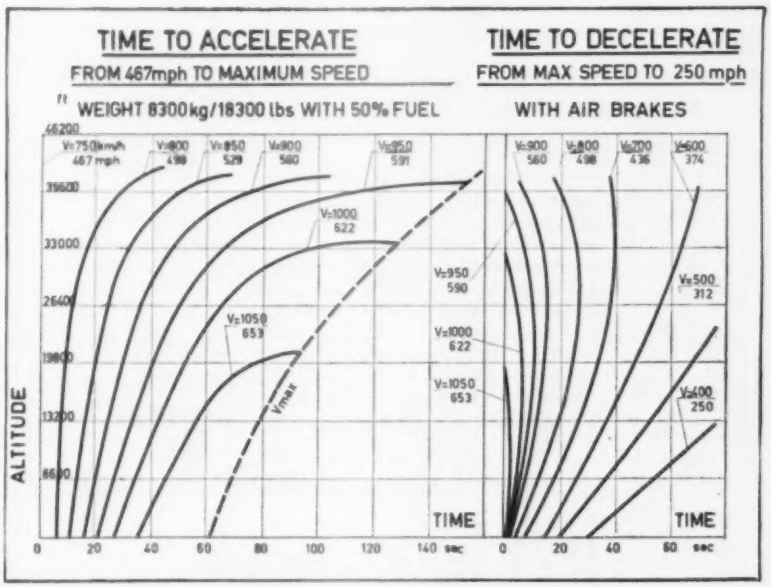
This particular installation increases the lift coefficient of the wing by about one-third, say company engineers.

Structural design of the wing was simplified by the decision not to carry fuel or to make any large cutouts in it. Final wing design is a multiple-box layout using eight vertical shear webs and covered by one-piece tapered skin. Prototype airplanes had a corrugated sandwich wing structure, but for production the tapered skin is a better solution.

Wing Leading Edge

Wing leading edge, including the flap, is made of a magnesium-zirconium casting extending right through the fuselage, and acting as part of the primary stressed structure. This leading edge casting carries leading edge flap hinges and their operating gear, aileron control rods and tip-tank attachment points.

The only cutout of any size in the lower surface accommodates the landing-gear strut, and as such is of minimum chordwise width. Two cast spanwise spars from the front and rear members of the cutout, and there are



BRAKING EFFECT of the perforated speed brakes on the P.16 fuselage is depicted at right.

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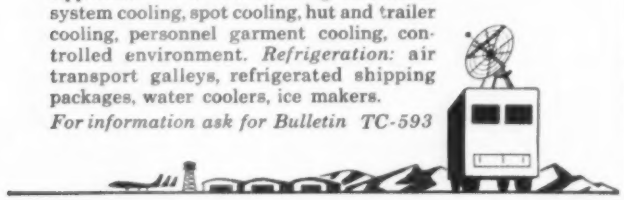

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also three heavy cast ribs in each wing panel.

Flaps and ailerons are lowered for landing configuration by chain-driven spindles. Eight bolts attack the wing to the fuselage.

Final structure of the wing is very stiff. During strength tests at ultimate load factor of 12.75, wing deflection was measured at 11.4 in., and after load relief, the residual deformation was 0.1 in. Under conditions of inverted pullout and a loading of 141% of the ultimate load (−9 g), wing behavior was purely elastic.

Fatigue Investigations

Detailed fatigue investigations were done for airframe points where the highest stresses were found during static load tests. As a result of continuous design refinement during the development of the airplane, FFA engineers believe the P.16 can show very high fatigue life.

They attribute this to a design philosophy which was based on a consistent application of stressed-skin techniques avoiding stress concentrations, and designing for high static reserve factors with a positive margin between actual and allowable stresses throughout the structure.

Basic structure of the fuselage and tail surfaces is conventional, but the surface controls are foam-filled and covered with very thin aluminum alloy skin.

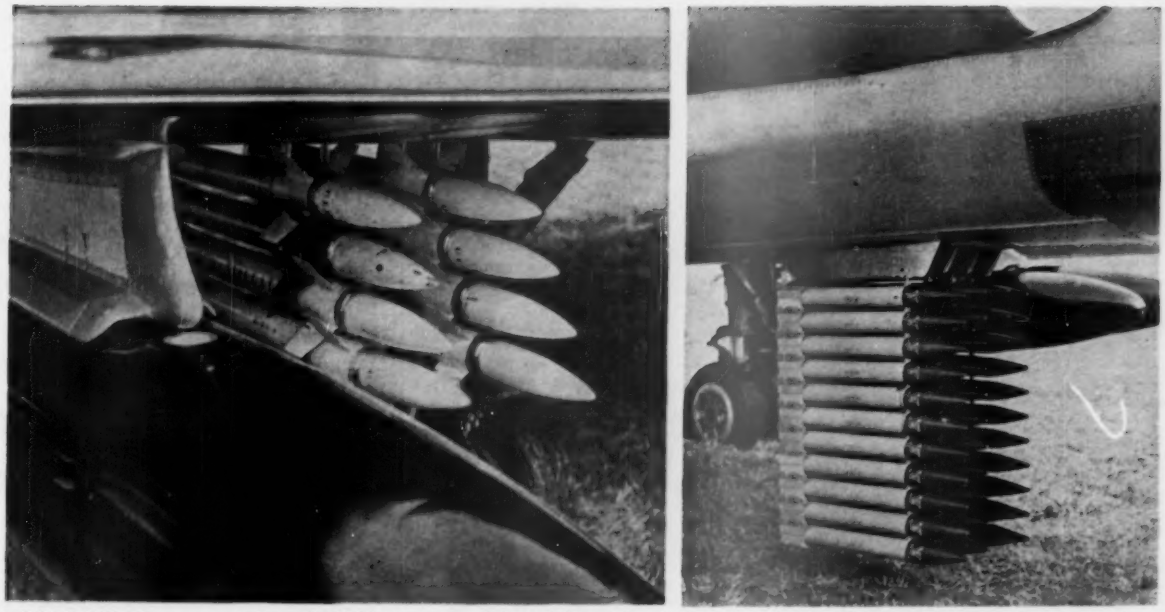
Low-Pressure Tires

Landing gear is the Dowty liquid-spring type. Both nose and main gear have twin wheels; tire pressure on the nose wheel gear is 78 psi., and on the main gear is 97 psi. But the use of the double-wheeled layout gives a lowered footprint pressure roughly equivalent to low-pressure tires (on the order of 50 psi.). There is the further advantage of having double braking energy available with disk brakes on both wheels.

FFA made taxi and takeoff tests on the wet grass side strips at Sion Airport, operating the P.16 at a gross weight of 20,800 lb., slightly over its normal takeoff figure. The turf was not penetrated by the P.16 wheels, but the standard Swiss army four-wheel "Jeep-type" truck went right through the turf and left water-filled channels behind its wheels.

Takeoff distance under the test conditions was about 3,300 ft., but other tests on drier grass fields showed figures averaging 2,400 ft. for takeoff, and as low as 1,400 ft. landing distance using the brake chute. Without the brake chute, landing run was 2,700 ft. average.

Armament of the P.16 is planned around the primary role of ground attack. Basic installation is a pair of 30-mm. Hispano-Suiza HS 825 revolver cannon, with a muzzle velocity of about



WING ROCKETS are mounted on the P.16 in groups of four (left), with only the top rocket secured to the wing and the rest mechanically interlocked until fired. What appear to be forward fins are actually the rear stabilizing fins for the rounds, mounted on a slip ring. The body of the rocket increases slightly in diameter toward the rear so that when the rocket is fired it moves forward through the slip ring and jams the fin assembly on the rear body. Technique is designed to reduce dispersion. Belly rocket launcher (right) holds 44 Matra Type 1000 air-to-ground rockets, 2.68 in. in dia. Rack is shown fully extended for loading; for firing, only two rockets protrude at an instant below the fuselage, and one of them is being fired at that moment.

3,600 fps. Rate of fire is 1,000 rounds per minute, and there are 125 rounds per gun in the P.16.

A large variety of additional armament can be fitted to the P.16, depending on the target and mission requirements.

Alternate installations combining rockets, bombs, or fuel tanks can be added to the twin 30-mm. cannon, up to a maximum overload armament weight of 5,700 lb., one of the heaviest loads toted by a single-engine jet airplane.

Major component of the hitting power of the P.16 is a 44-round automatic rocket launcher installed in the belly. Launcher and rockets are made by the French firm of Matra. Rockets are unguided folding-fin Type 1000, and measure 68 mm. (about 2.7 in.) in diameter. Rockets are linked in a network of four rows of 11 rounds each.

Rocket Firing

For firing, the rockets are dropped automatically below the fuselage, extending down the depth of two rockets below the skin line. This distance is maintained during the firing sequence; the bottom round is fired, and then the whole launcher drops down one rocket diameter, so that the next live round is exposed and fired. Warheads for these air-to-ground rockets can be either explosive or hollow-charge for tank-busting.

The wings carry 12 attachment positions that can be used to hang clusters of four Hispano-Suiza HSR 80 air-to-ground unguided rockets. These rounds, available either with hollow charge or explosive warheads, measure 80 mm. (about 3.1 in.) diameter.

Dispersion of these rockets has been reduced to a figure comparable to that of cannon—a few per cent circular error probability—by means of the launching technique.

The rockets appear to have forward fins instead of aft stabilizer surfaces. Actually these "forward" surfaces are the tail fins, mounted on a ring whose diameter is just a little larger than the diameter of the rocket body forward of the tail. When the rocket is fired, it moves forward through the ring and is steadied by the ring which acts as an elementary tubular launcher. As the rocket moves forward, it picks up the ring-mounted tail assembly because the body diameter of the round increases slightly toward the tail. The fin assembly jams on the body as the rocket leaves the cluster.

Each fin has a slot near the trailing edge which interlocks with a slot in the fin leading edge of the rocket above it in the cluster, forming a rigid matrix of four rounds when they are mounted on the launch point.

In addition to the 12 rocket launch points, there are four bomb racks fitted under the wings, making it possible for the P.16 to carry a wide variety of external stores in addition to the rockets. Standard loads would be made up from multiples or combinations of 450-, 1,000- or 2,200-lb. bombs; 100-gal. napalm bombs; rocket containers holding 19 or 31 Matra 68-mm. rounds; homing missiles; guided bombs; 100-gal. auxiliary fuel tanks; or combined 75-gal. auxiliary tanks carrying reconnaisance cameras.

Normal Armament

Normal armament installation weight runs from the 380 lb. of the twin cannon installation to a maximum of 3,990 lb. Overload operations start with armament weighing 4,590 lb. and go to maximum weapons weight of 5,700 lb.

Fuel system of the P.16 is simple, and involves three tanks: the two wing tanks and a fuselage collector tank. Compressed air feeds the fuel from the 253-gal. tip tanks to the fuselage collector tank which holds 151 gal. Fuel is then pumped electrically from the collector tank to the engine pump which in turns feeds the high-pressure fuel nozzles.

Refueling point is a single connection on the lower fuselage side; it can be fed with fuel pressures between 15 and 45 psi. Fuel can be jettisoned from lines in the tip tank; it takes about one minute to dump the entire supply.

Hydraulic system is the same as before the troubles, and only minor changes—none of basic design—have been made. The main hydraulic fluid tank is divided into two compartments

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making a main and an emergency system. The main side is handled by an engine-driven hydraulic pump feeding the system at 3,000 psi. The emergency system uses a separate electric pump with a 2,430-psi. feed pressure. Control and longitudinal trim system, flaps, landing gear, wheel brakes, speed brakes and leading edge flaps are hydraulically operated.

If the main system fails, the control system has an emergency hydraulic standby system and a manual mechanical standby system. Trim is then done manually. Nose flap and wheel brakes have emergency systems driven by hydraulic accumulators, and the main landing gear is blown down by a nitrogen system.

Electrical system is a 6 kw. generator plus a 35-amp./hr. nickel-cadmium battery for the main electrical components. An emergency electrical system uses a 16 amp./hr. battery as the main power source.

Conventional instrumentation for flight and engine is provided, but there are additional systems demanded by modern military requirements.

Radio Aids

The P.16 carries both main and standby VHF equipment or AN/ARC gear for communications; Ferranti Mk. 8 gunsight radar; Lear ADF 100 radio compass; Lear yaw damper; IFF equipment on request; Peravia or Sperry HL 7 gyro-horizon; bomb-aiming equipment, such as a toss-bomb computer; Tacan air navigation with data link.

Cabin pressurization maintains atmospheric pressure up to 9,000 ft., and a 3 psi. differential above that height. Graviner fire-warning and extinguishing system is installed. There are g-suit connections.

Brake chute has electromagnetic release gear developed by Dassault in France, and a Kostelezki ribbon brake chute.

The ejection seat is a Martin-Baker Mk. 4 type, which gives low-level bail-out down to about 50 ft. above the ground.

Fairchild gunsight cameras are fitted in the wingtip tanks, and a Ferranti recorder camera is tied into the Mk. 8 gunsight radar. Reconnaissance cameras can be installed in the noses of two auxiliary fuel tanks.

Vickers to Build Hovercraft Vehicle

London—Commercial development of the Hovercraft air-cushion vehicle will be undertaken by Vickers, Ltd., at the Vickers-Armstrongs works at South Marston.

This development was announced by Vickers and Hovercraft Developments, a subsidiary of the government-backed National Research Development Corp. which sponsored the vehicle.

Work will begin immediately on prototypes in two size categories, the smaller being about the same size as the current four-ton experimental vehicle SR.N1, with the role of a fast launch.

F-86 Jet Boost

Performance of the North American F-86F Sabre jet for an interceptor role has been increased from 650 mph. and 45,000 ft. to supersonic speed and more, then 60,000 ft. altitude, using a Rocketdyne auxiliary AR2-3 aircraft rocket engine (AW Feb. 22, p. 55).

The small rocket, throttlable from 3,000 lb. to 6,000 lb. thrust, uses the plane's JP-4 fuel in combination with 90% hydrogen peroxide as a hypergolic bipropellant combination. It is one of a family of small aircraft rockets developed by Rocketdyne.

The aircraft was tested using Sidewinder missiles as weapons, and a Tacan navigation system. Two 250-gal. drop tanks of oxidizer were carried. The rocket engine, gas generator and turbopumps for propellant supply are housed in a centerline belly blister about half the size of the plane's canopy.

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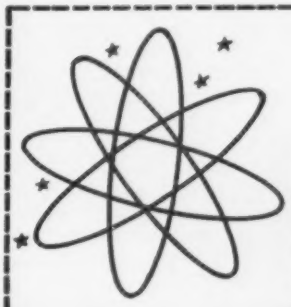

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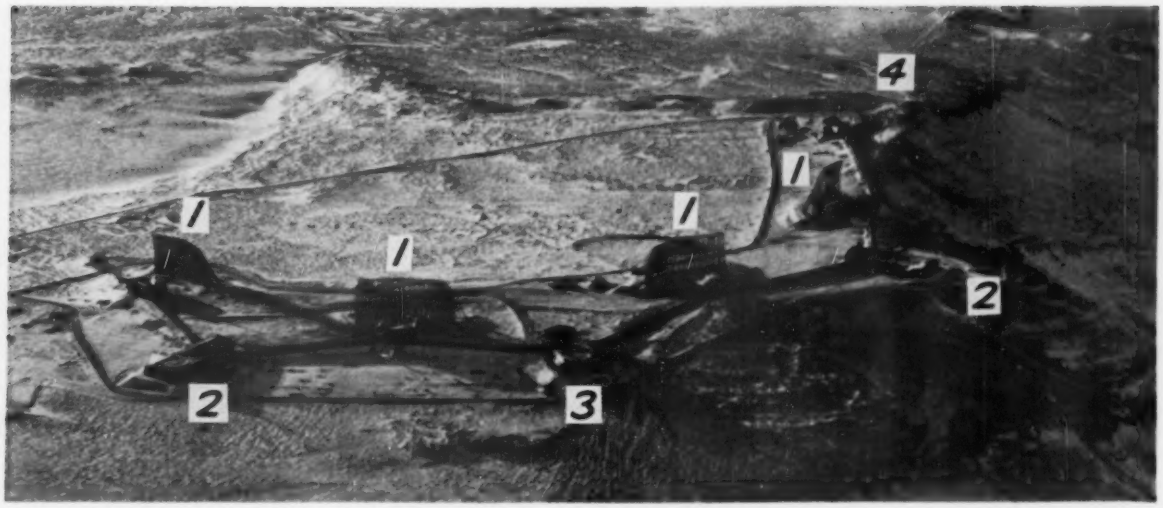


AERIAL VIEW of first Ballistic Missile Early Warning System, to go into operation this fall, shows site layout at Thule, Greenland. In front of each of the four giant detection radar antennas (1) is a pipe-organ type scanner building. Radar transmitters and receivers are housed in two buildings (2) as well as in building which houses tactical displays and data processing equipment (3). Service buildings (4) are at extreme right. All buildings are connected by 6,000-ft. passageway.

First BMEWS Nears Operational Status

By Philip J. Klass

Thule, Greenland—Air Force's first Ballistic Missile Early Warning System (BMEWS) site, the largest, most complex military electronic facility ever constructed, is expected to become operational this fall, only 2¼ years after first contracts were awarded.

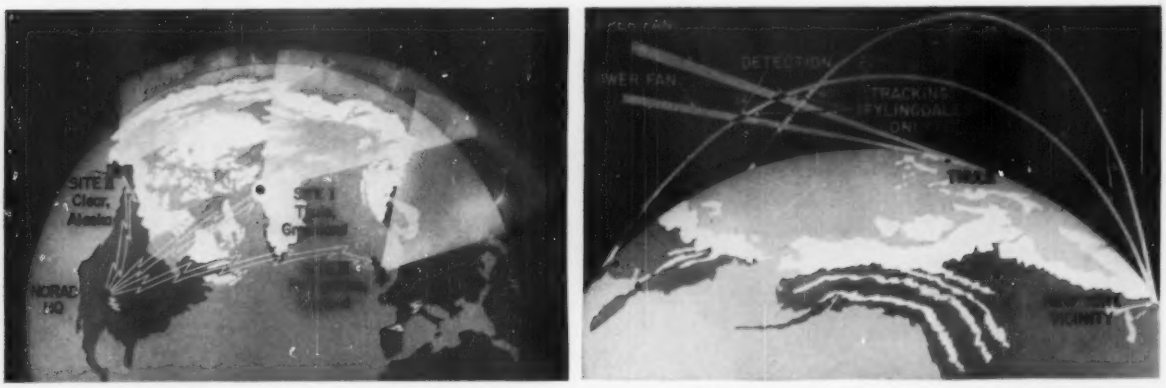
Four powerful detection radars of the BMEWS site here, located 900 mi. from the North Pole and roughly midway between New York and Moscow, will be able to probe several thousand miles to give Strategic Air Command bombers and missiles at least 15 min. warning of a mass ballistic missile attack.

First operational test of the BMEWS site here is expected to use polar orbit satellites as targets. Second of the three planned BMEWS sites, at Clear, Alaska, is scheduled for operation in the summer of 1961, with the third site in Britain to follow shortly afterward.

The four giant detection radar antennas here, each standing 165 ft. high and measuring 400 ft. long, larger than a football playing field, are themselves almost dwarfed by the huge crescent-shaped BMEWS installation itself which extends more than a mile in length. The installation is situated atop a cliff which overlooks a fiord and the Greenland icecap.

Metal Passageway

An enclosed metal passageway, large enough to accommodate battery-powered trucks, connects the four antenna scanner buildings, two radar transmitter/receiver buildings, a tactical control and data processing building and several service buildings. More than 21 mi. of huge waveguides, resembling



DETECTION COVERAGE of three programed BMEWS sites in Greenland, Alaska and Britain together with the dual rearward communication circuits which link them with North American Air Defense Command and Strategic Air Command Headquarters are shown in sketch at left. Thule BMEWS site can give as much as 40 min. warning for ICBM with high-energy trajectory (42 deg.), or 22 min. for minimum-energy trajectory (23 deg.) attacking New York (right). Dual radar beams enable BMEWS to tell whether object is an ICBM, also its launch and impact points.

large heating ducts, line one side of the passageway to carry power from the radar transmitters to the scanner buildings.

Originally the BMEWS sites in Greenland and Alaska were to have AN/FPS-49 tracking radars in addition to the AN/FPS-50 detection radars (AW July 28, 1958, p. 19). The FPS-49 is produced by Radio Corps. of America, which also is the BMEWS systems manager; the FPS-50 is produced by General Electric's Heavy Military Electronics Department.

After the program was under way in early 1958, Air Force took a close, hard look at original cost estimates and decided that originally planned facilities could not be obtained within budgetary limits. Air Force therefore decided to forego the FPS-49 tracking radars at least initially.

However, foundations and pedestals have been constructed here so that tracking radars can be added later if desirable and if funds permit. Cost of adding three tracking radars here and two at the Alaska BMEWS site is estimated at around $75-100 million.

British Base

The joint British-U.S. BMEWS installation to be made at Fylingdales will use only the RCA tracking radars. Only the RCA-developed radars are now planned. Decision to use the RCA radars for both detection and tracking is based in part on the fact that Western Europe represents a relatively small target area and that IRBM rather than ICBMs represent the major threat.

Thus, broad-angle detection radars are not required.

Total cost of the BMEWS site here is estimated at about $500 million. Slightly smaller installation in Alaska, with three detection radars, will cost about $328 million. Site in Britain will run about $115 million. British will pay for facilities construction costs, estimated at about $35 million, with the U.S. providing radars and associated equipment. Installation will be operated by Royal Air Force and USAF. Britain will pay annual operating costs; the U.S. will supply spare parts.

A few years ago, it would have been considered technically impossible to design a radar with a detection range of more than 2,000 mi. against a small target the size of a missile warhead. Yet today, General Electric engineers on the site here show no doubts that the FPS-50 can accomplish detection ranges which would have been incredible a few years ago.

This confidence is born of experience with General Electric's predecessor equipments, such as the FPS-17 installed in Turkey and a later version installed in Trinidad to track missiles fired

AIR FORCE'S first Ballistic Missile Early Warning System (BMEWS) site in Greenland will go into operation this fall only two years after construction was started near Thule AFB, approximately 900 mi. from the North Pole and roughly midway between New York and Moscow. Much of the construction was carried out during long Arctic night.

THREE PRECISION tracking radar antennas, produced by Goodyear Aircraft, with 84-ft.-diameter dish, will be installed at BMEWS site in Britain. Antenna contour must be maintained to within 3/16th of an inch. The AN/FPS-49 tracking radars, made by RCA, may also be installed at BMEWS sites in Greenland and Alaska if funds permit.

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THIRD BMEWS site, in Britain, will employ three AN/FPS-49 tracking radars to be used both for detection and tracking.

from the Atlantic Missile Test Center.

The FPS-50 operates in the lower portion of the ultra-high frequency band.

Each radar antenna produces two beams which simultaneously scan in azimuth, utilizing a pipe-organ type feed array and large scanning switches. One beam has an elevation angle relative to the horizon of 2-5 deg.; the other an elevation angle of 6-10 deg. The four antennas at this site collectively produce an azimuth radar coverage of about 150 deg.

Time Interval

By measuring the time interval between target interception of the two beams, target radial velocity by means of doppler shift, and using conventional methods of determining target bearing and range, BMEWS computers obtain sufficient information to determine whether the target is following a ballistic trajectory or whether it is a satellite or meteor.

If the target shows warhead characteristics, computers supplied by Sylvania Electric, can also compute its launch and impact areas.

The eight radar beams are powered by a total of 20 radar transmitters, each employing klystron tubes rated at "several megawatts" peak power. By means of switches operable from the tactical control center, several transmitters can be paralleled to increase the penetrating power of any antenna beam.

Recently developed low-noise parametric amplifiers were not used in the FPS-50 receivers because their design had to be frozen before the parametric amplifiers had proven their practicality. The addition of such amplifiers, involving relatively minor cost, should make it possible to extend the range of BMEWS radars.

No Radar Scopes

Because the power level of the received signal (echo) from a nose cone at a range of several thousand miles is only a milli-micro-microwatt (a thousandth of a billionth of a watt), it would not be distinguishable from background noise to a human operator if displayed on a conventional radar scope.

The extremely weak signal must be integrated and otherwise enhanced, then

analyzed by computers for characteristics which mark it as a signal return as distinguished from random noise or echos from natural phenomena such as meteor trails. Such enhancement and analysis must be performed at speeds far beyond the capability of human operators.

BMEWS does not, therefore, use conventional cathode ray tube type displays. Target data from digital data processing equipment is displayed on tote boards and consoles, using colored, illuminated panels which are easy to read and understand.

Information on ballistic missile targets, their calculated launch and impact areas, together with a status report on the configuration and performance of radar equipments, is displayed simultaneously at the BMEWS site and at North American Air Defense Command (Norad) and Strategic Air Command Headquarters.

The display includes a statistical measure of the "confidence level" of the target data displayed, based on the quality of signals, performance of radar sets, atmospheric conditions and other factors.

Digital Data

Data for display at Norad and SAC headquarters is transmitted in digital form over two completely separate communication systems. Western Electric is a BMEWS prime contractor for rearward communications. One is a submarine cable, actually two cables separated by a moderate distance, recently laid to Thule for the BMEWS site. The other is a high-power AN/FRC-47 tropospheric scatter system which links Thule to the Cape Dyer terminus of the DEW Line, which in turn has rearward tropo scatter circuits back to commercial Canadian telephone circuits. The FRC-47 is a quadruple diversity system, employing dual antennas and both horizontal and vertical polarized transmissions to assure extreme reliability.

The tactical display message from BMEWS sites is transmitted in digital form, using audio-tone modulation. The message itself consists of 63 bits, to which are added another 18 bits for er-

BMEWS Contractors

Nearly 3,000 companies participated in the USAF's Ballistic Missile Early Warning System (BMEWS) program, prompting some to refer to it as the "nation's biggest industrial togetherness program." Major contractors and their responsibilities include:

- Radio Corp. of America: prime contractor and systems manager. RCA also supplies the AN/FPS-49 tracking radars and automatic checkout and monitoring equipment for entire system.
- Western Electric Co.: prime contractor, responsible for rearward communications from BMEWS sites.
- General Electric: subcontractor, responsible for AN/FPS-50 detection radars.
- Sylvania Electric: subcontractor, responsible for automatic data processing system, including equipment for converting radar output from analog to digital form and digital computers (manufactured by International Business Machines Corp.) for analyzing target trajectory and threat.
- Goodyear Aircraft Co.: subcontractor, responsible for building 50-ft. pedestal and 84-ft. diameter parabolic antenna used in AN/FPS-49 tracking radars as well as radomes that enclose antenna.

Principal subcontractors to General Electric on its AN/FPS-50 detection radars include:

- Continental Electronics Manufacturing Co.: radar transmitters.
- D. S. Kennedy & Co.: antennas.
- General Bronze Corp.: scanner switches.
- Eitel-McCullough and Varian Associates: klystron transmitting tubes.

RCA says that approximately 66% of the total BMEWS contract has been subcontracted and that approximately 36% of the total expenditures have gone to small business firms.

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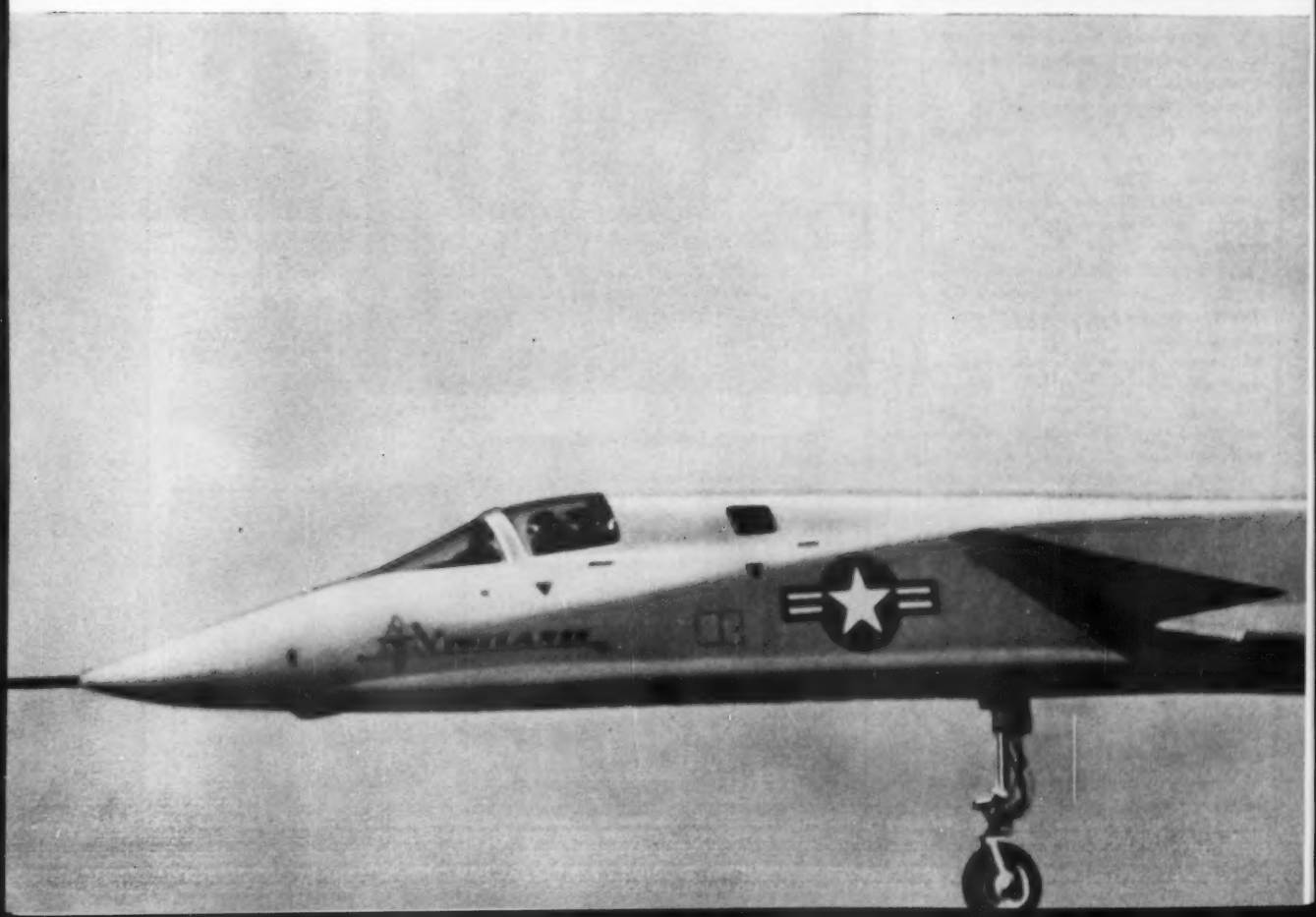
USS Strux takes the shock as the Vigilante "hits the deck"

Key parts of USS STRUX in the main landing gear include outer and inner cylinders, and wheel fork. STRUX packs about seven per cent more strength per unit of weight than other alloy steels commonly used for critical landing gear forgings.



With the landing gear down and locked, the Navy's newest Mach 2, carrier-based, supersonic attack aircraft, the A3J Vigilante, swoops in to "hit the deck." This marks the first use of USS STRUX in main landing gears and nose gear assemblies.

USS STRUX is an *ultra*-high-strength alloy steel, developed by United States Steel, for use in aircraft. It can be forged, machined and heat-treated to develop strengths in the 280.000 to 300,000 psi range with adequate toughness. Compared with SAE 4340, frequently used in landing gear components, STRUX has about 7% more strength and, as proved by landing gear makers, can reduce weight by a comparable amount.

Today, with the emphasis on reliability of landing gear components, USS STRUX certainly deserves your serious consideration. And the importance of weight savings are obvious to anyone making aircraft or missiles.

The primary STRUX components in the Vigilante's main landing gear include the outer cylinder, inner cylinder (piston) and fork, and a trunnion. The nose landing gear uses an inner cylinder and a fork made of STRUX. Engineers tested every facet of STRUX's mechanical properties and workability before specifying it for the A3J landing gear. Each main gear must withstand shock loads that can run well over 100,000 pounds.

U. S. Steel sells Strux in the hot rolled or annealed condition in a full range of bar sizes, in blooms and billets up to 15¾ inches square or in flat rolled products as required.

For more information on USS STRUX, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania, or contact the nearest USS District Sales Office. Comprehensive technical data is available at no obligation.

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The Navy's new A3J Vigilante, produced by North American Aviation, Inc. Landing gears are built by Bendix Products Div., Bendix Aviation Corporation.

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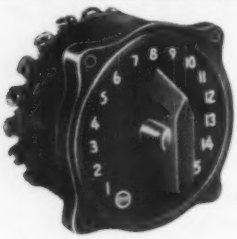

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The cases are splash proof and dust tight, of close fitting bakelite. Husky black-finished aluminum indexing knobs are used to turn the stainless steel shaft supporting the rotating brushes.

RESISTANCE BULB SWITCHES

A companion line of the same construction except that they are fitted with a common-terminal ring for three-wire bulb connections.

THE 9S SERIES
THE SPACE SAVERS

FOR AIRCRAFT RESISTANCE THERMOMETERS

1¼" dia.

Small, sturdy, steel-cased switches 1¼ inches in diameter, 2-9/32 inches total shaft length, one hole mounting with ½-32 NS-2A threaded bushing. Designed especially for connecting two or more resistance temperature detectors to one instrument, now flying in the modern jets.

Write for our descriptive bulletin on Selector Switches

The LEWIS ENGINEERING CO.
Specialists In Temperature Measurement
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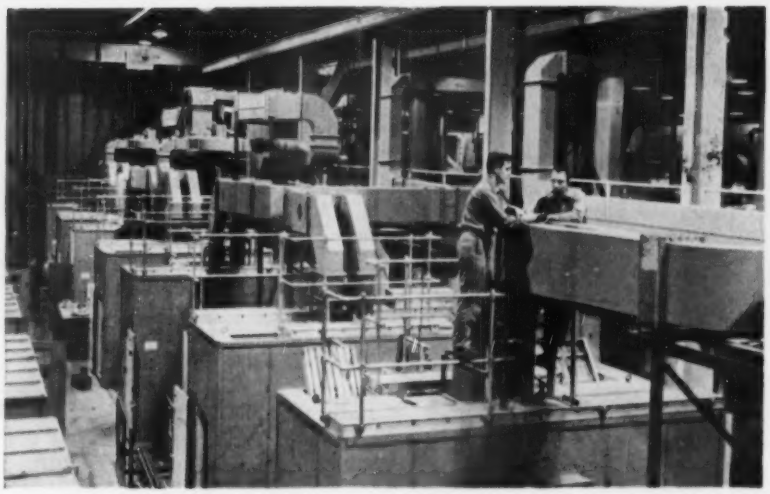


TRANSMITTERS for high-power BMEWS radars, contained in cabinets shown above, pipe megawatt-level power to antenna scanners through huge waveguides shown. Elaborate switching system permits several transmitters to be paralleled for increased range or to be switched to other antennas in the event their transmitters malfunction.

ror detection using triple interleaved parity checks.

At 1,000 mi. intervals along the two rearward communication routes from BMEWS, the messages are automatically subjected to an error (parity) check. In addition, when the identical messages arrive at Norad over the two routes, they are compared. If there is no discrepancy, the message goes to the display boards. If there is a difference between the two messages, the BMEWS site is automatically requested to retransmit the message.

To continuously monitor and exercise these vital rearward communications circuits during periods when there are no fresh tactical messages to be transmitted, automatic checkout equipment at the BMEWS site will transmit test messages at the rate of eight per second. If only six correct test messages per second are received, an amber alert sounds; if circuit deteriorates to the point that only four correct test messages per second or less are received, then a red alarm sounds to alert operating and maintenance personnel.

Phone Circuits

In addition to the data link circuits, there are telephone and teletype circuits which can be employed for transmitting tactical data in an emergency.

When the DEW Line was built, stations with rotating surveillance radars were placed only 100 mi. apart so that if one station had to shut down, adjacent stations could cover its sector. Because of the extremely high cost of a BMEWS installation, such backup is not feasible.

Instead, RCA and its subcontractors have used every conceivable technique to build this backup capability into each BMEWS site so that round-the-clock operation is assured.

Starting at the sub-subsystem level, wherever feasible, redundancy has been designed into the equipment. For example, the stable local oscillator in each of the transmitter/receiver buildings is provided in duplicate. Both equipments are operated continuously although only

FEATHERWEIGHT PRESSURE INDICATOR

This B.F.Goodrich Pressure Indicator incorporates an Omega-design bellows, which closes a contact when pressure reaches a preset value in the range of 250 to 500 p.s.i. Device is less than 1 inch long, weighs under half an ounce. Now used in primary missile batteries and torpedo batteries; special design can be built to meet your needs. Write for complete information.

B.F.Goodrich
aviation products
Dept. AW-5E, Akron, Ohio

one of them is "on-the-line." Built-in monitoring circuitry checks the performance of both equipments. If there is significant degradation or failure of the on-line equipment, it is automatically switched off the line and the other equipment is connected into service. The operational status of all equipments in the transmitter-receiver building is shown on a console in the building's monitor room.

The Missile Impact Predictor Set (MIPS), which analyzes radar data to determine type of target, impact area and launch area if it is a warhead, and total numbers of warheads, employs two IBM 7090 solid-state digital computers. The two computers simultaneously solve the same problems then compare solutions to be sure they are identical before transmitting results to master displays.

In addition, each machine periodically subjects itself to a test problem, whose answer is known, to check all of its internal elements. If a machine fails to pass the test problem, a loud alarm sounds to alert the operator.

Every major equipment contains its own built-in monitoring which continuously checks critical voltages, waveforms or other operating parameters to detect the first signs of deterioration in performance or failure. The operating status of each equipment in the transmitter-receiver buildings is indicated in the individual building's monitor room.

In addition, there is a central over-all system monitor which displays the operating status of every element in the entire site. This room is adjoining the tactical control room in the center building which houses data processing equipment, plus some radar transmitters and receivers.

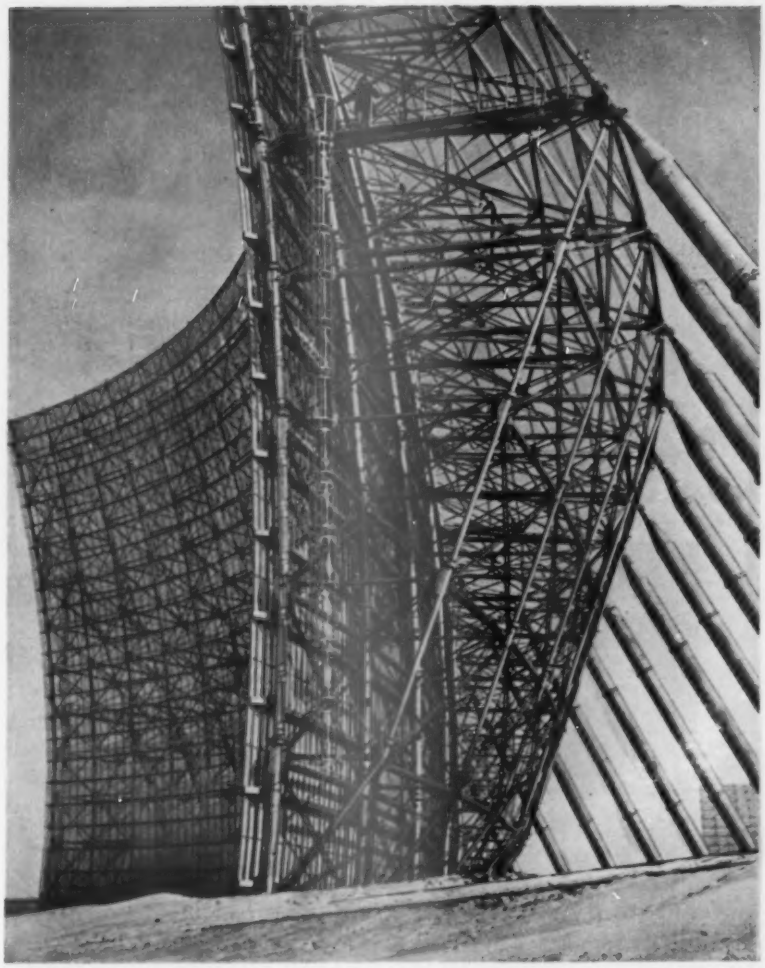
Checkout Development

RCA, in addition to its systems management and FPS-49 responsibilities, developed the automatic monitoring and checkout equipment for the over-all system. In addition to the over-all system performance monitoring in the central monitor room, the RCA equipment also provides simulated ballistic missile attacks, programed on magnetic tape, which check the performance of the complete system except for the antennas. The test program input to the system is introduced at the RF level by probes in the scanner waveguide.

Some idea of the complexity of the over-all BMEWS installation here can be gained from figures on the total number of basic components used in the system. These include:

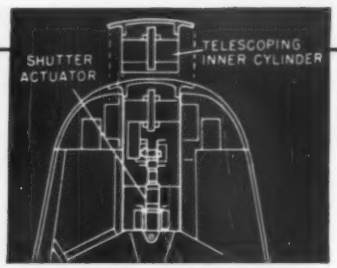
- **315,000 transistors.**
- **33,000 vacuum tubes.**
- **270,000 capacitors.**
- **1 million resistors.**
- **300 mi. of cables.**

When system malfunction is de-



ANTENNA for General Electric AN/FPS-50 detection radar stands 165 ft. high, 400 ft. wide, larger than a football playing field. (For relative size, note man on catwalk.) Four of the 1,500-ton antennas, produced by D. S. Kennedy & Co., are installed at Thule BMEWS site. Antenna is torus shaped, i.e. circular in horizontal plane, parabolic in vertical plane. Automatic checkout system, developed by RCA, continuously monitors and tests performance of entire BMEWS facility, localizing fault when a malfunction occurs. Console shown below gives complete visual report on operating status of every major element in the BMEWS site, including vital rearward communications circuits to U.S

Where you *must* have actuator reliability... look to Airborne



Detail of GE-built Nuclear Emulsion Recovery Vehicle (NERV) shows location of Airborne actuator used to extend and retract emulsion package. Requirements call for operation at temperatures from –65 to 160°F; altitudes to 200 miles and beyond. Weight of actuator: 1.2 lb.

Among the more critical of recent Airborne actuator applications is that on the National Aeronautics and Space Administration's NERV vehicle, where a linear actuator is required to extend and retract a nuclear emulsion package. In fact, success of the vehicle's mission—study of the lower Van Allen radiation belt—depends to no little extent on reliable functioning of this one component alone.

In initial firings, the 75-lb. NERV will be carried to an 800-mile altitude by Argo D-8 rockets. The flight program calls for energizing the actuator at 120 miles up, thereby opening the shutter and telescoping the emulsion package out from the front of the nose cone. This condition is maintained until the vehicle is within 200 miles of the ground on the way down, at which point the actuator retracts the emulsion package, closing the shutter.

Noteworthy also in this application are some of the prime contractor's quality assurance tests, including acceleration to 125 g; sound pressure level of 160 decibels minimum; and shock loading of 50 g.

Whatever your requirements in electromechanical actuation—linear or rotary—you can depend on Airborne to help you achieve highly reliable componentry. For information or proposals, contact any of our offices.

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tected, a series of tests contained on punched cards or tape can be used to track down and isolate the fault to a major subsystem.

Systems Compared

Because the DEW Line and BMEWS both are designed for early warning and both are Arctic installations, it is interesting to compare the two though they are complementary.

The $500 million cost of building the BMEWS site here in Thule is slightly less than the cost of building the complete DEW Line, with its nearly 60 stations stretching across 3,000 mi.

However, where the bulk of the DEW Line cost went for construction of facilities rather than for radar and communications equipment, the reverse is true for BMEWS. Because the majority of DEW Line stations were built at isolated locations, it was necessary to construct landing strips, water supplies, roads and other service facilities at each site. The BMEWS site here, located only 12 mi. from the main Thule Air Force base, could utilize many of the existing facilities.

The 700 persons who will be required to operate the BMEWS site here on a round-the-clock basis are about 300 less than the number required to man the DEW Line. However, BMEWS personnel will be housed and fed (except for mid-day meal) at Thule AFB and the base also will provide many service facilities. DEW Line stations must provide all such services and facilities themselves. (BMEWS site will contain emergency dormitory and eating facilities when blinding "white-outs," or "phases," produced by 100 mph. velocity winds that blow snow off the icecap and strand personnel at the site.)

In terms of cost and operating personnel, the single BMEWS site here is roughly equivalent to the 60-station DEW Line, which gives an indication of the magnitude of the undertaking.

Civilian Personnel

RCA will provide civilian personnel to operate the BMEWS sites here and in Alaska, at least for the initial year and possibly longer. Total annual operating cost for this site is estimated at $100 million, slightly less than the cost of operating the DEW Line which is carried out by Federal Electric Corp. under USAF contract.

If location of BMEWS sites near existing air bases eased some of the construction problems, compared with DEW Line construction, there were many new problems peculiar to BMEWS. For example, the huge 1,500-ton radar antennas had to be designed, and anchored, to withstand winds with velocities of up to 200 mph.

The concrete antenna bases had to

be built to prevent any settling which could cause antenna misalignment. When concrete hardens (cures), it gives off heat which could melt the frozen ground and allow the concrete to settle or shift position. To prevent this from happening, copper tubing was placed in the wet cement and refrigerated water was passed through the tubing to carry off the curing heat and prevent the frozen ground from melting. The tubing remains in the hardened concrete.

To prevent settling of the concrete floors in scanner buildings, which would defocus the antenna, ducts were laid under the floor and cold air is continuously circulated to prevent building heat from melting the ground underneath.

Handling the difficult Arctic construction problems of this sort was the responsibility of the Army Corps of Engineers, under the management eye of the Air Materiel Command.

Air Force spokesmen pay tribute to the cooperation of the Danish government in the BMEWS program. The Island of Greenland is a constitutional part of the country of Denmark. A number of Danish citizens are employed in the site construction and wherever possible will be employed for the operating and maintenanec staff at the site.

Haloid Xerox Makes RC Circuit Modules

Rochester, N. Y.—Technique of making microminiature RC circuits by chemical etching of multilayered, precoated ceramic wafers and interconnecting them with end wafers to form modules has been developed here by Haloid Xerox, Inc.

Resistance-capacitive circuits are formed by successive deposition of resistive, conductive, dielectric and then conductive films without regard to geometry by vacuum evaporation on ceramic substrate. All layers except the dielectric film completely cover the substrate. Specific circuits are then formed by selective xerographic stenciling and etching.

Resistance values from a few ohms to a megohm and capacitances from a few picofarads to near 0.02 microfarads have been achieved. Notched 1-in.-square RC circuit plates can be stacked by insertion into slotted end wafers. Holes in the end wafers enable conventional active components to be mounted in end wafers between and parallel to RC circuit plates. Precoated conductive material on end plates is etched to form conducting paths and tabs protruding from end plates are solder-dipped for interconnection. Project is sponsored by Air Force Cambridge Research Center.

Flight Patterns Displayed in 3-D

Detroit, Mich.—Chrysler Corp. has developed a new plotter that will make three-dimensional graphs of aircraft and missile flight patterns.

Coupled to radar and an analog computer, the 3-D plotter can record and present an almost instant picture of a vehicle's flight path. At the present time, there is a great deal of three-dimensional data—for example, from a missile flight test—that, by necessity, is being presented in two-dimensional form. As a result, Chrysler's Robert Felts points out, it is difficult, if not impossible, for the eye to get an image of what is really happening.

One new 3-D plotter is scheduled to be installed at a still unnamed air terminal for evaluation in approach control while other early production models are expected to undergo tests at White Sands Missile Test Range. Among other possible applications for the plotter, some of which are now under study by Chrysler, are weather plotting, satellite tracking, anti-aircraft fire control, anti-submarine warfare, and wind tunnel data display. The company itself is interested in using the plotter for programed machine tool control.

This is how the device works: A stylus, driven in three axes by three positional servo loops, is suspended in a tank of transparent gel. Signals from an analog computer to the servomotors move the stylus. Inside the stylus are three ink channels for multi-color tracings. Normally, the ink will be fluorescent for greater vividness under ultraviolet lighting.

As the stylus moves through the gel, the ink is pressure fed out of the stylus into the gel. The gel closes behind the stylus, like quicksand, trapping the tracings. The ink traces can be kept precisely suspended in the gel as long as desired and then erased with a suction tube, or disappearing ink can be used.

For the future, Chrysler engineers are working on an electronic version of the plotter in which a three-dimensional reading scope will replace the gel, pen and ink.

NEW PLOTTER makes and leaves three dimensional ink tracings in transparent gel.

Flight Propulsion

880's START COMMERCIAL SERVICE

CJ-805's Power Delta Jetliners

Atlanta, Ga.—General Electric engines entered commercial service for the first time on May 15 when Delta Air Lines Convair 880 Flight #873 left New York's Idlewild Airport bound for New Orleans' Moisant International Airport.

DAL Flight #873 was the world's first 880 passenger service. It inaugurated Delta jet service to New Orleans.

The second 880 flight left the ground while the first was still in the air, and Delta 880 service was fully underway.

A pre-service Delta flight demonstrated the capabilities of the fastest and the newest of the jets.

Delta's first 880 established a new coast-to-coast speed record on its recent initial cross-country pre-service flight. The 880 "Delta Queen" flew the 2359 miles from San Diego to Miami in 3 hours, 31 minutes, and 54 seconds.

Average ground speed for the record-breaking flight was 665 miles per hour.

Delta President C. E. Woolman, aboard for the flight, said, "This new southern transcontinental speed record clearly establishes the General Electric-powered Convair 880 as the queen of the skies. The aircraft performed magnificently and fully measured up to my expectations for both plane and engine."

More information on Convair 880s powered by General Electric jet engines is found in GED-4192. See coupon.

IT'S A SWEET AIRPLANE—C. E. Woolman (left), Delta Air Lines President, discusses coast-to-coast record-breaking flight with T. P. Ball, Delta's chief pilot.

General Electric's T58 Turboshaft Engine Completes 2000-Hour Endurance Run

Lynn, Mass.—General Electric's 1050-shp T58 turboshaft engine recently completed 2000 hours of endurance running. The gruelling test, designed to determine T58 parts life expectancy, simulated the demands which the engine would face during 4000 typical 30-minute helicopter missions. In all, 4000 starts and 12,000 burst accelerations were made. Condition of parts was excellent.

Developed for the U.S. Navy, the T58 is now in production and has accumulated more than 30,000 hours of total running time. Military applications include the Navy's HSS-2 and HU2K helicopters, the Army YHC-1A, and two experimental vertical take-off and landing (VTOL) aircraft, the Kaman K-16 and Fairchild M224.

The engine's commercial counterpart, the CT58, has been selected to power Sikorsky S-61s, ordered by Los Angeles Airways and Chicago Helicopter Airways and Vertol 107s, which New York Airways plans to use. The CT58 also powers Sikorsky's S-62 single-engine amphibious helicopter being offered to corporate charter and airline users.

More detailed information on the T58 program is found in GED-3985. See coupon.

2000-HOUR ENGINE INSPECTED—M. C. Hemsworth, G-E Small Aircraft Engine Department Manager of Engineering (right), examines T58 compressor with evaluation engineer J. W. Wills.

J85-7 Powers GAM-72 To New Altitude

Holloman Air Force Base, N. M.—McDonnell's GAM-72 decoy missile successfully completed its first free flight recently with General Electric's J85-7 production turbojet, the engine slated to power the "Green Quail" when it enters service with the Strategic Air Command. Air launched at operational altitude from a B-52 bomber, the missile completed its automatically-programmed flight without incident, reaching the highest altitude of all flights to date.

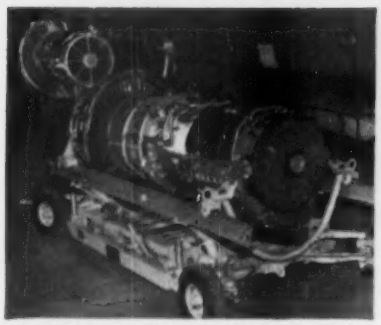
Although the GAM-72 has been free-flown with a development J85 engine, this was the first in a series of mission simulation flights aimed at paving the way for release of the production missile system to operational SAC squadrons.

J85 engines have now compiled more than 11,000 total test hours.

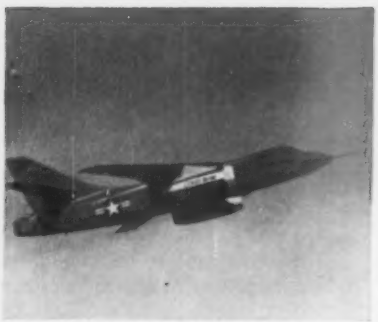
More information on G.E.'s J85 production turbojets, for "Green Quail" and other applications, is available in GED-4096. See coupon.

NEWS

A report about progress in products from the Flight Propulsion Division of the General Electric Company.



CJ-805-23 ENGINES POWER FLIGHT—General Electric's aft fan engines power the B-66.



B-66 POWERED BY AFT FAN ENGINES—G-E leased aircraft in flight, fitted with Convair 600 nacelles.

CJ-805-23 Highly-Successful: 1st U.S. All-Turbofan-Powered Flight

Edwards AFB, Calif.—For the first time an engine manufacturer flew turbofan engines as primary powerplants when General Electric successfully flight-tested two CJ-805-23 engines recently. A G-E leased Air Force B-66 flew for one hour and 40 minutes at altitudes up to 35,000 feet, and speeds up to Mach .85.

Flight tests are continuing with outstanding success.

Both engines are mounted in Convair 600 production nacelles. Through these tests, General Electric will supply significant data on the pods, before the 600 flies for the first time.

The aft fan CJ-805-23s underwent extensive ground tests in Convair nacelles before the historic flight.

Convair 600s, equipped with the CJ-805-23s, have been ordered by American Airlines, Scandinavian Airlines System, Swissair and REAL (Brazil).

As part of its continuing aft fan flight test program, General Electric recently purchased a Caravelle VII from Sud Aviation. Wind tunnel tests of the Caravelle aft fan nacelles have already begun. Flight tests will begin in early Fall, leading to early certification of the aft fan-powered jet.

If you'd like additional information about any of G.E.'s aft fan engines, mail the coupon below. For CJ-805-23 information, GED-4192; CF-700, GED-3986; TF-35; GED-4098.

4000-LB THRUST AFT FAN IS UNVEILED—This is the first full-scale mockup of General Electric's new CF700 turbofan engine, recently announced as the first small aft fan engine specifically designed for light- and medium-weight aircraft being offered to corporate, military and airline users. Being developed under G-E sponsorship, the CF700 combines the J85 gas generator and a scaled-down version of the CJ-805-23 aft fan to produce 4000 lbs thrust with a 0.69 SFC. Flightworthy engines will be available in April, 1961; FAA-certified engines in February, 1962. More CF700 information is contained in GED-3986.

B-58 TIME RECORD SET

Fort Worth, Tex.—The Air Force's B-58 "Mary Ann," powered by General Electric's J79-5A turbojets, made a routine flight of 18 hours and 10 minutes recently to set a new "Hustler" endurance record.

"Mary Ann" was refueled twice during the flight. Piloted by Lt. Col. Leonard A. Legge, the B-58 took off from Carswell AFB at 6:40 p.m. March 22 and landed on the same strip at 12:59 p.m. the following day. The flight covered approximately 11,000 statute miles.

FAA Awards CT58 Production Certificate

Lynn, Mass.—General Electric's Small Aircraft Engine Department has been awarded the first original helicopter gas turbine production certificate to be granted by the Federal Aviation Agency. The certificate authorizes quantity production of G.E.'s CT58-100 commercial helicopter engine without FAA inspection of each individual powerplant.

The engine itself was certificated by the FAA for commercial helicopter service on July 1, 1959.

PRODUCTION CERTIFICATE AWARDED—G-E Small Aircraft Engine Department General Manager Gerhard Neumann (left) accepts production certificate number 107 from Walter H. Ross of FAA.

The advantages of CT58-powered commercial helicopters are described in detail in G.E.'s illustrated brochure, GED-3987. See coupon below.

FOR MORE DETAILED INFORMATION on these and other developments in General Electric aircraft powerplants, contact your nearest G.E. Flight Propulsion Division representative or indicate below the brochures you would like to receive.

General Electric Company
Section A206-11
Schenectady 1, New York

- ☐ GED-4192, "CJ-805 Progress Report"
- ☐ GED-3986, "CF700-1 Turbofan"
- ☐ GED-4098, "Aft Fan Flight Test Report"
- ☐ GED-3985, "T58 Progress Report"
- ☐ GED-3987, "CT58 for Commercial Helicopters"
- ☐ GED-4096, "J85 Progress Report"

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GENERAL ELECTRIC

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▶ **Very High Power Transistors**—New family of high frequency silicon transistors, which have maximum collector currents as high as 100 amp., giving them a power rating of up to 1,500 watts, has been developed by Pacific Semiconductors, Inc., under Wright Air Development Division sponsorship. Engineering samples of a 10 amp. unit, rated at 150 watts, are now available, PSI's Frank J. Steinebrey told the recent Naecon in Dayton. One such unit has been operated at 10 mc. with an output of 109 watts and a collector efficiency better than 50%, Steinebrey reported. Transistors will be available in two packages, one for air cooling, the other for water cooling.

▶ **Less Automation For Space GSE**—Ground support equipment (GSE) required for space probes is less automated, less complex, less costly than that needed for weapon systems, Milton C. Peterson of Space Technology Laboratories told the Dayton Naecon. "For one-of-a-kind space probes, it is more expedient and reliable, and also more economical to use highly trained personnel than to spend time and money for the design of sophisticated equipment," Peterson said. He also pointed out that severe weight restrictions on space payloads eliminates the use of normal conveniences such as test plugs, mechanical access points and lifting points. C. T. Everson of Lockheed's Missile and Space Division, pointed out another important difference between space vehicles and weapon systems: the latter need to be kept on continuous alert, ready for launching on a few minutes notice, which requires continuous monitoring, while space vehicles do not.

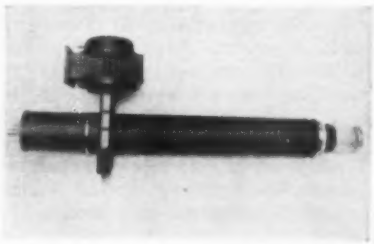
▶ **Reflections on Reliability**—Daniel E. Noble, executive vice president of Motorola, told Naecon that "When I attended my last meeting on reliability, I sensed an atmosphere not unlike that which would exist in a group of hospital patients all suffering from anemia who had gotten together to exchange blood transfusions."

▶ **FM/AM Telemetry Proposed**—Recommendation that present FM/FM frequency division telemetry system, which has been the standard for 15 years, be changed to FM/AM, was made at Naecon by Prof. Lawrence L. Rauch of the University of Michigan. The change, Rauch said, would reduce amount of radio spectrum used and would permit use of better demodulation and data reduction methods. He conceded that there would be a slight loss in signal-to-noise ratio by changing to amplitude modulation, but added that this would be more than compensated for by the improved data processing which FM/AM reportedly makes possible.

▶ **Scatter Detection of Space Objects**—Adaptation of forward-scatter communications techniques might prove suitable for detecting satellites, Capt. Peter Tokareff, Jr., Wright Air Development Division, suggested in a report to Naecon. Proposed technique would spot satellites by detecting ground transmitted energy which bounces off ionized trail produced by the satellite and is received at another station. Optimum frequency would be about 50 mc., Tokareff estimates.

NEW AVIONIC PRODUCTS

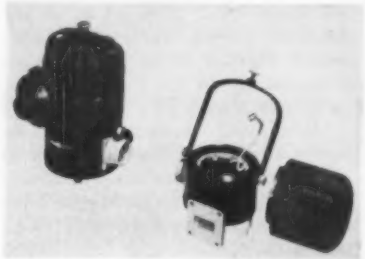
• **Klystron amplifier tube,** L-3270, is capable of producing better than two megawatts of peak RF power with 100 mc. bandwidth centered at 1.3 kmc. in



L band. Amplifier has minimum gain of 30 db., flat bandpass and linear phase shift characteristics over specified bandwidth.

Litton Industries, 960 Industrial Rd., San Carlos, Calif.

• **Klystron tube mounts,** DB-111, are designed to provide coupling between output of small reflex klystron and standard size wave-guide. Units are insulation-tested at 1,500 v. peak and are available in five sizes to handle tubes

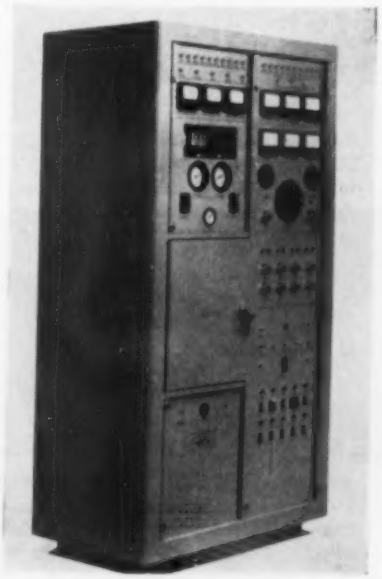


in 2.6 to 9.6 kmc. frequency range. Prices are $237 to $315, depending on size and configuration, and 30 day delivery is offered.

DeMornay-Bonardi, 780 Arroyo Pkwy., Pasadena, Calif.

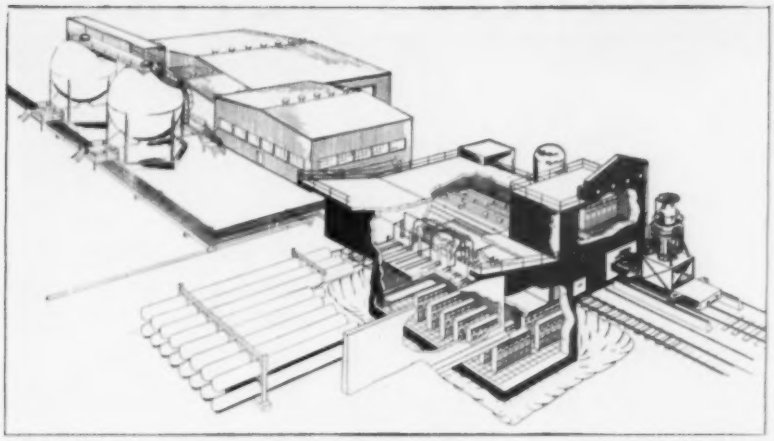
• **Synchro servo repeater,** which includes gear train, motor tachometer, control transformer, transistorized amplifier and power supply, has zero backlash between the synchro control transformer and output shaft. The 26-v. repeater, has rated static accuracy of 0.25 deg. maximum at a 7 min. synchro input, velocity constant of 500 deg./sec./deg. and a slew velocity of 30 rpm. Input requirements are 115 v. 400 cps. at 7 va. Dimensions are 2⅝ in. diameter by 4¾ in. long.

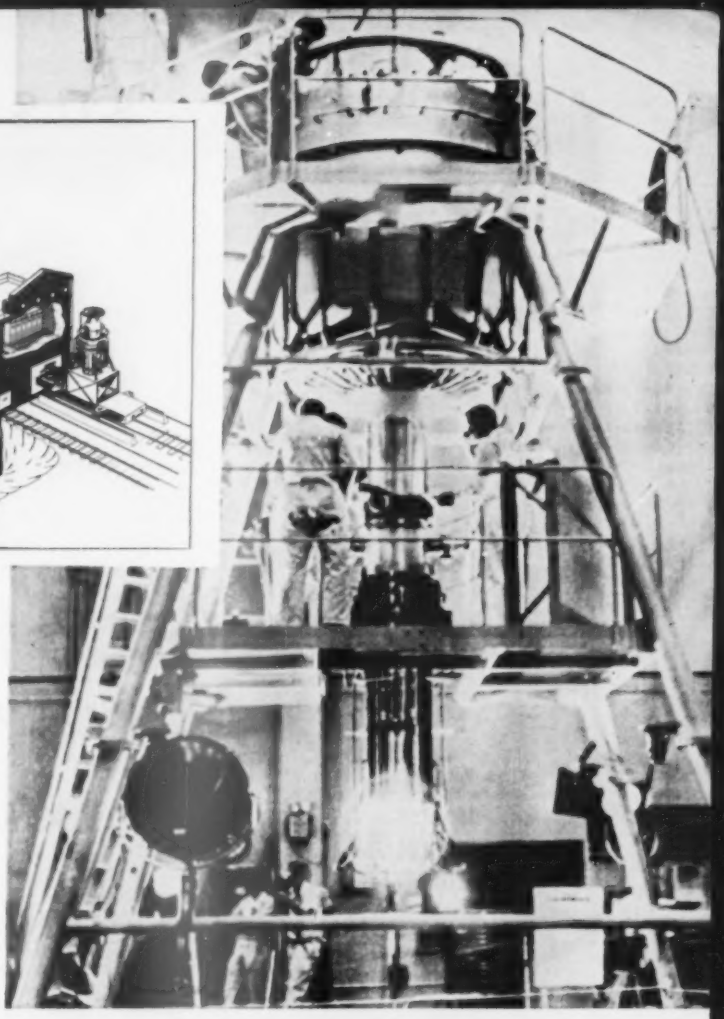
Orbit Instrument Corp., 131 Eileen Way, Syosset, N. Y.



• **Klystron power amplifier,** Model 210 A, supplies 2 kilowatts and operates over 7.125 kmc. to 8.5 kmc. range with a gain of better than 40 db. when operated as broadband amplifier. Maximum bandwidths at ½ power points are 15 mc. staggered tuned, and 10 mc. synchronously tuned.

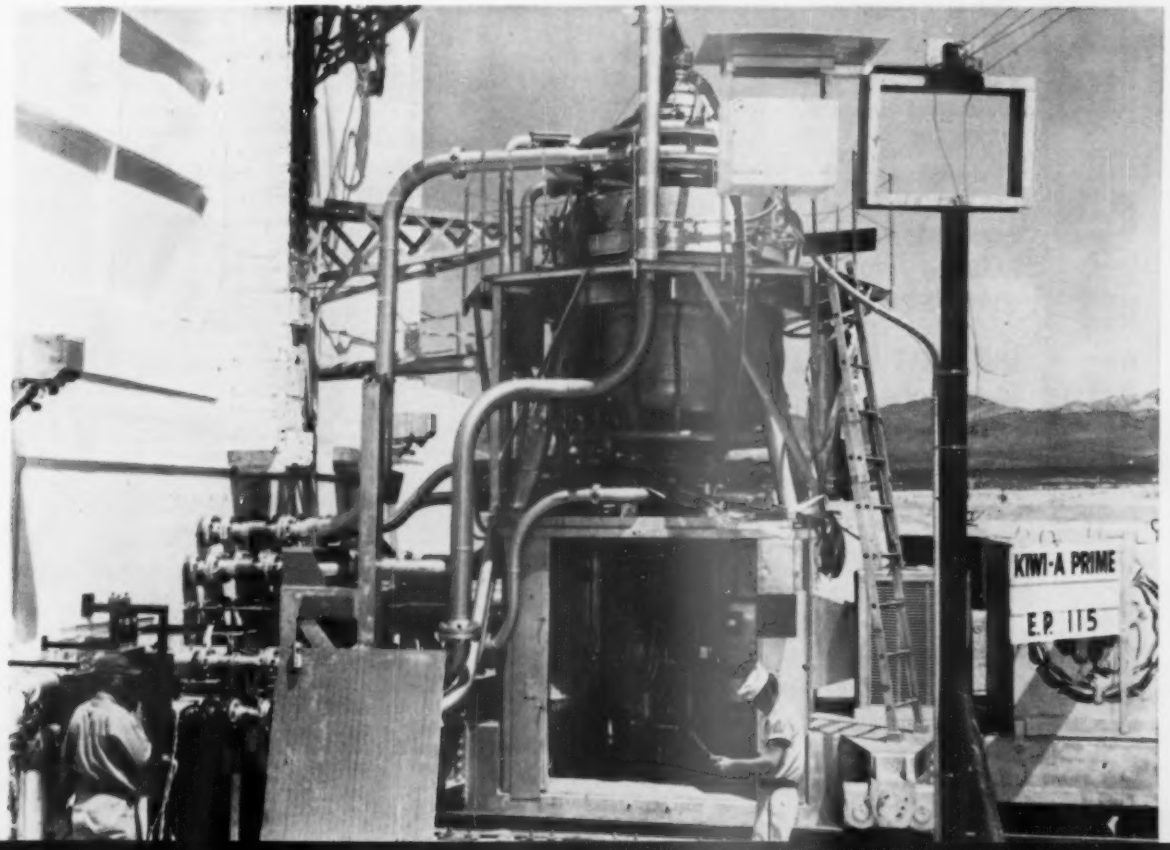
Sierra Electronic Corp., 3885 Bohannon Dr., Menlo Park, Calif.





Second Project Rover Reactor Prepared for AEC Power Runs

Second reactor in the Project Rover nuclear rocket propulsion program, Kiwi-A Prime (above right) is scheduled to begin power runs in July at Atomic Energy Commission test site in Jackass Flats, Nev. Test Cell C (above), for a more advanced reactor that will use liquid hydrogen as a working fluid, is expected to be ready for use next year. Kiwi-A Prime, like its predecessor Kiwi-A, will use gaseous hydrogen (AW May 23, p. 37). Mock-up of Kiwi-A Prime (below) will be used to check instrumentation for actual reactor. Rover program is a joint project for AEC and National Aeronautics and Space Administration.



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BUSINESS FLYING

ARTIST'S conception, shown above, of SIAT 222 shows excellent cockpit visibility.

Four-Seat SIAT 222 Prototype Nears Completion in Germany

Hanover, Germany—First prototype SIAT 222 is now nearing completion at Donauworth, Germany, and is expected to make its first flight early this fall.

Siebelwerke ATG, GmbH. of Donauworth, a member of the Bölkow Group, announced the new low-wing, all-metal, four-seat plane at the air show here.

The aircraft is the next step in Siebelwerke's prewar SIAT 202 Hummel two-seat series, which still holds two world records for high altitude flight.

Designed primarily for sport and business flying, the SIAT 222 is also suitable as a trainer and for glider-towing purposes. In addition, as a single-seater, it is fully aerobatic.

Powerplant is a single four-cylinder, air-cooled Lycoming engine rated at 180 hp., driving an electrically-controlled, variable-pitch Hoffmann propeller. Maximum speed is 199 mph.

Wing tips are detachable and, to enable the plane to start or land on very small airfields, the outer wing sections are fitted with flaps, the center sections with uninterrupted split flaps.

Fuselage is an all-metal, monocoque structure. Cockpit, fitted with dual control sticks, allows all-round visibility. The cabin has upward-opening doors, one on either side which provide easy entrance or exit. A jettison hand-operated lever is provided to detach the doors in an emergency.

Baggage space, accessible from outside, is provided both in front of the cabin and to the rear of the back bench.

Both nosewheel and landing gear of the aircraft are mechanically retractable and oleo-pneumatic shock absorbers cushion both starting and landing operations considerably.

Normal standard instrumentation is provided and full blind flying equipment is available as an optional extra.

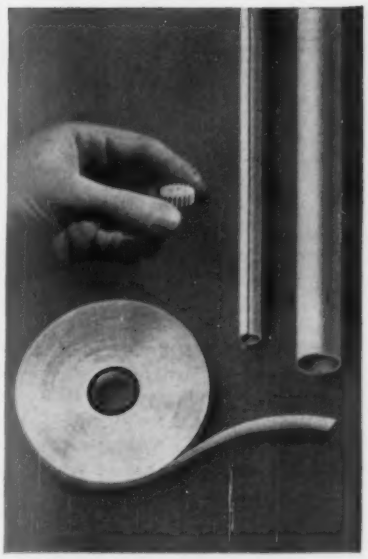
A definite price for the SIAT 222 has not yet been fixed, but Siebelwerke expects to market the standard model for about $15,500 (DM 62,000) and a more refined version for approximately $17,500 (DM 70,000) including blind-flying instruments.

SIAT 222 Specifications

Dimensions	
Span	30.18 ft.
Length	25.12 ft.
Height	8.07 ft.
Wing area	131 sq. ft.
Aspect ratio	6.66
Weights	
Empty weight	1,188 lb.
Useful load	1,020 lb.
Gross weight with four passengers	2,200 lb.
Gross weight with two passengers	1,892 lb.
Gross weight with one passenger	1,441 ib.
Performance	
Maximum speed	199 mph.
Cruising speed	180 mph.
Landing speed	61 mph.
Rate of climb	21 fps.
Service ceiling	22,300 ft.
Range	745 mi.
Takeoff distance (49 ft.)	903 ft.
Landing distance (49 ft.)	689 ft.
Fuel	
Contents of wing-tip containers	23 gal.
Contents of auxiliary containers	7.7 gal.

Fairchild F-27, Convair 240 Executive Interiors

Interior of an F-27 Friendship turboprop executive transport demonstrater, owned by Fairchild Engine & Airplane Corp., was designed for low density seating by Horton & Horton Custom Works, Inc., Ft. Worth, Tex. Below is interior of Frederick B. Ayer & Associates' new Convair 240 demonstrator in 17 passenger configuration (AW Apr. 4, p. 139), which was modified by AiResearch Aviation Service Co.; gross weight is 42,500 lb.



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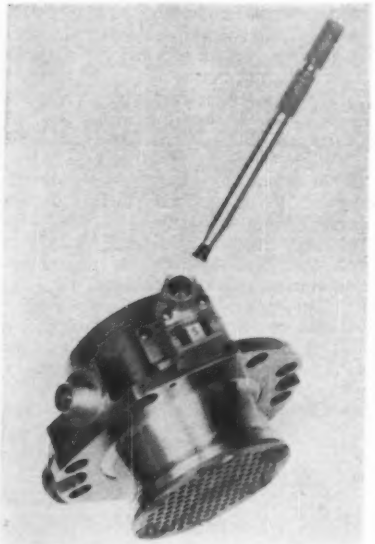
Bulova ICBM Igniter Has Safety Feature

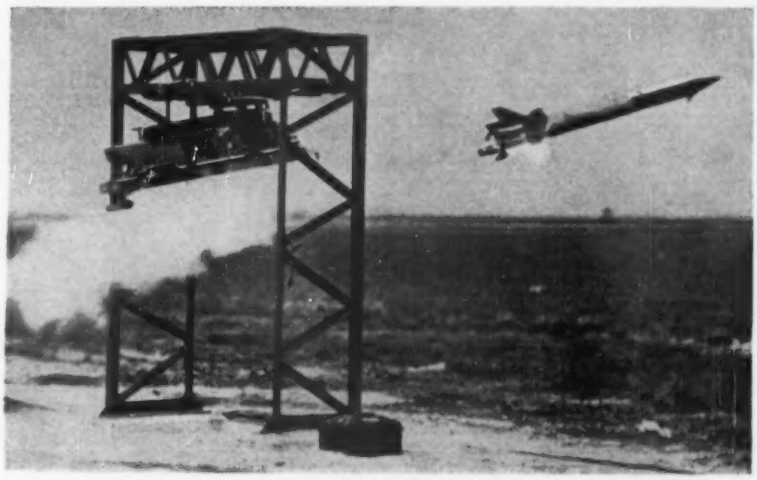
Woodside, N. Y.—Bulova Research and Development Laboratories has developed a novel igniter safe-arm mechanism for the first stage Minuteman intercontinental ballistic missile rocket engine. Several units have been delivered to Thiokol and are now undergoing preproduction qualification testing.

Dual purpose of the new mechanism is to prevent accidental first stage ignition and, at the same time, to ensure that the engine will fire when it is supposed to. To achieve these often contradictory goals of adequate safety and reliable ignition, the Bulova unit employs a unique pyrotechnic train with only one moving part.

An early approach to the problem suggested the commonly used method of interposing a metal barrier between the electrical squibs and igniter pellets (both contained in the igniter boss at the fore end of the first stage engine). Prior to ignition, the barrier would be rotated out of the way. But to adequately contain the heat and flame from an accidental firing of the squibs, engineers found, the barrier had to be so large that it lowered the reliability of propagation—that is, when the barrier was rotated out of the way for a planned firing, the resultant gap was so wide that the ignition force from the squibs would not always span it with sufficient energy to set off the igniter pellets and initiate burning in the large first stage engine.



MINUTEMAN first stage igniter safe-arm mechanism can be mechanically safed (note "S" in window) by pushing special tool shown into opening above window. Tool is also used to remove expanding steel collet in the mechanism that serves as a safety lock during shipment and storage.



Martin Bullpup Trainer Missile Fired in Tests

Martin TGAM-83 trainer version of the Martin Bullpup air-to-surface missile is fired from a wing-type launcher affixed to a ground test stand at Naval Air Test Center, Patuxent River, Md. Martin is producing the trainer version for Air Force pilot training in North American F-100 jet fighters.

Brought into the program with a subcontract from Thiokol, Bulova found that there was no way in the conventional safe-arm-ignition scheme to separate the safety problem from the propagation problem. Bulova scientists took a different approach—one in which the two problems could be separated—and developed a device in which the squibs can be brought close to the igniter pellets as necessary to ensure propagation and ignition without affecting safety in any way.

To achieve this separation of safety and ignition, they mounted two squibs and electrical switches on a motor shaft assembly which rotates inside a stationary housing that holds the igniter pellets. In the safe position, the squibs face an extra thick section of the stationary igniter pellet housing that would block flame and heat from an accidental firing of the squibs. Also, in this position, electrical contacts to the squib inputs are open and each squib is shorted through itself to prevent premature activation of the squibs by electrical noise or the like.

To arm the unit, an electrical signal is sent to the motor and the shaft assembly holding the squibs and electrical switches is rotated approximately 120 deg. to the arm position. In this position, the firing-pulse path is closed, and the squibs face a section of the igniter housing that is only .005-in. thick. When the firing signal is given, the squibs blow through the thin wall and detonate 60 grams of igniter pellets contained in an annular cavity of the surrounding stationary housing.

The confined igniter pellets burn rapidly, spewing flame and hot gases through a perforated plate in the base of the igniter housing into the engine casing where they initiate burning in the solid propellant grain. Once the unit is armed and before the firing signal is given, the device can be returned to a safe position either electrically or mechanically. (An operational requirement specifies that the device is to be armed only electrically.) An added safety feature of the mechanism is the visual indication of the status given either by the letter S or A which appears in a small window in the device. The hermetically sealed unit also has an electrical position readout as well as a mechanical steel collet locking device.

The igniter safe-arm mechanism weighs 4.2 lb.

It is 3.4-in. high by 4.75-in. in diameter, not including its projecting safing arm and connectors.

Bulova is also doing research and development on a destruct mechanism for the Minuteman first stage that for standardization purposes makes use of the same basic components used in the

Solid-Propellant Bids

Washington—Competition held by Wright Air Development Division for a one million-pound-thrust solid propellant rocket, in which Aerojet-General Corp. was adjudged the winner (AW Feb. 22, p. 38) has been re-evaluated and opened again for new bids.

These are expected to be submitted in near future by Aerojet, North American Aviation's Rocketdyne Division, United Technology Corp., Thiokol, Allegany Ballistic Laboratories and Grand Central Rocket Co., which were the finalist bidders and probably other companies.

Initial contract is expected to involve analysis and test of a model only one-fifth the length of an operational version, with a funding of about $3 million. Follow-on full-scale development contract may call for rocket delivery within 18 months.

igniter safe-arm device in a somewhat rearranged set-up. In the destruct device, which is set off to the side of the centrally located igniter boss on the fore end of the first stage engine, explosive detonators are used in place of somewhat longer burning, flame-producing squibs. The shock force from the detonator sets off a high explosive charge which shatters the motor casing in a controlled pattern.

Polaris Sub Simulator Designed for Navy

Minneapolis—New underseas warfare simulator, for training crews of Polaris fleet ballistic missile and other nuclear submarines and for use in war games, will be developed by Minneapolis-Honeywell's Ordnance Division under a $3.6 million contract awarded by the Naval Training Device Center.

The device, which will occupy an entire wing of a three-story building at Navy's submarine school at New London, Conn., will provide complete simulation of three nuclear submarines. Each trainer will contain radar and sonar screens at its command post showing the maneuvering of the simulated ships.

The new nuclear submarine simulator will be used for war-game-type operations, for training command and staff officers and for developing tactics, as well as for training members of submarine crews in use of their weapons for attack and defense.

Crews will be monitored from a master instructor's console and the over-all battle situation will be displayed on a large screen in a war games room. Heart of the system will be a Honeywell 800 digital data processing system.

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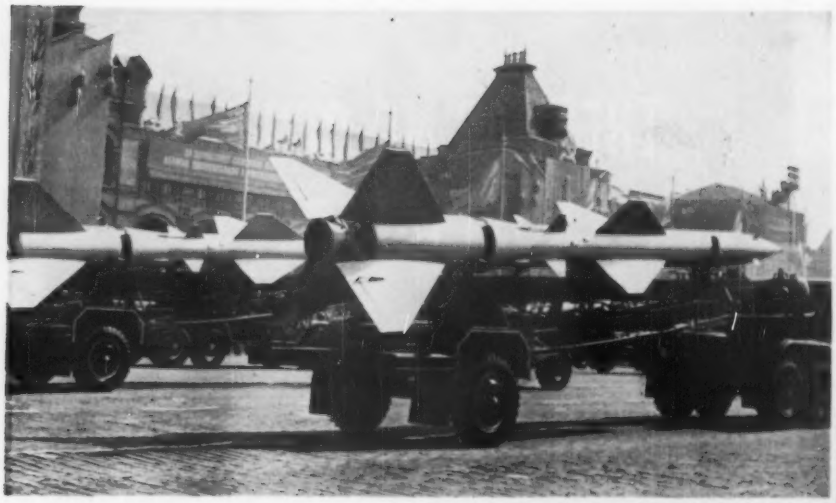
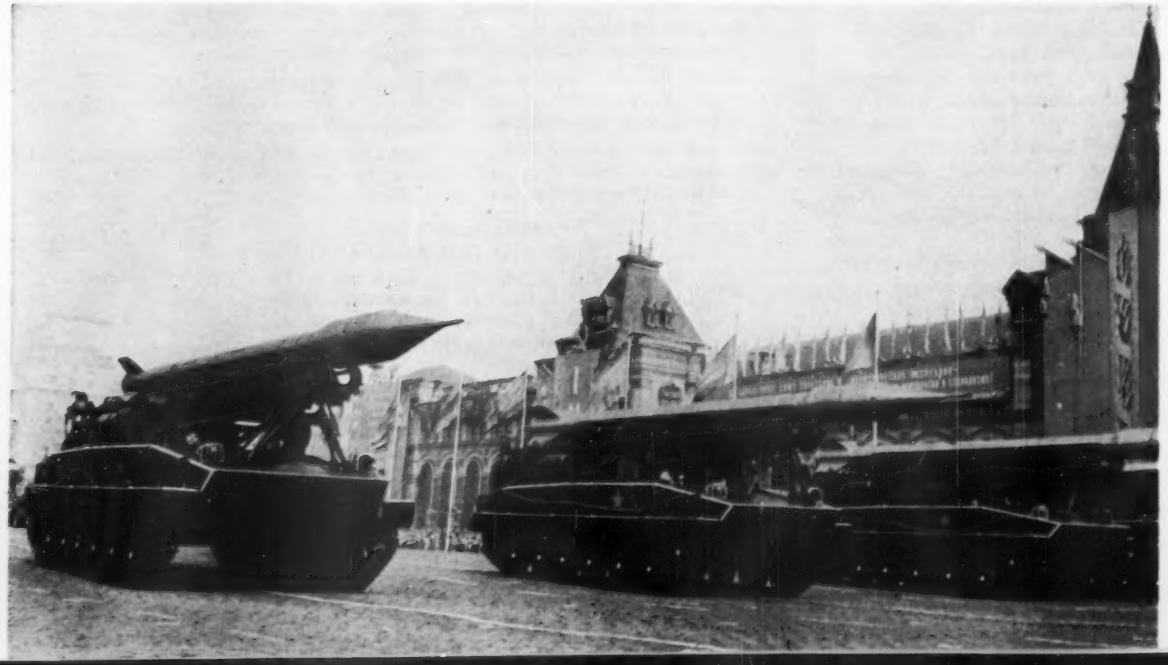
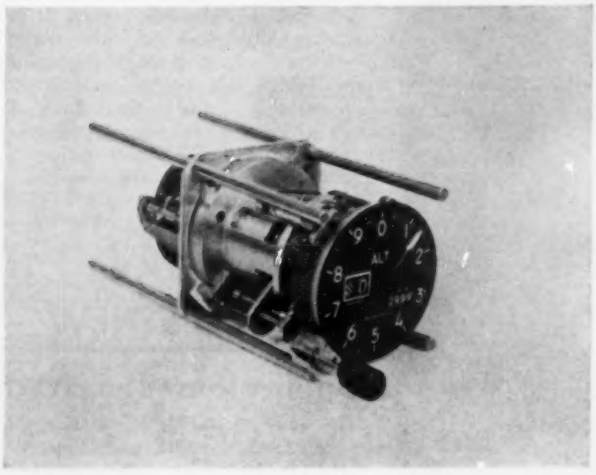


External Changes Noted In Soviet Missile Show

Missiles shown during the recent May Day parade in Moscow's Red Square were almost identical to those paraded here in the fall of 1957 when the Soviets provided the first public look at their missile arsenal during the 40th anniversary of the Communist revolution. External changes on the missiles are minor. Standard Soviet anti-aircraft missile (above and right foreground) apparently had eight new flush antenna locations near its nose. These missiles were followed by Honest John type rockets (below), liquid and solid fuel tactical missiles (range up to 200 mi.) and T2 type IRBMs.

New warhead shape was only significant change visible on tactical rockets (below) and their amphibious carriers during May Day parade.





PRECISION altimeter shows corrected altitude from data computer or a radio altimeter without dependence on electrical power.

USAF, Navy Evaluate Precision Altimeter

By Barry Tully

New York—New precision altimeter will display corrected altitude transmitted by synchro from a remote source with a fail-safe pressure mechanism to serve in the event of electrical malfunction. The altimeter, developed by the Kollsman Instrument Corp., has been ordered in evaluation quantities by the Air Force and the Navy.

The Kollsman compensated altimeter provides a counter-pointer altitude display reading from −1,000 to 100,000 ft. The advantages of the instrument are that it will display corrected altitude from an air data computer or a radio altimeter without dependence on continuous electrical power. In the event of electrical malfunction, the altimeter will revert to static pressure operation, indicate to the pilot that it is in the standby (less precise) mode and perform with the precision of a standard military MC-3 altimeter. The pilot may select the standby mode at his option or attempt to reset normal operation of the altimeter in the case of momentary power interruption.

Altimeter Reliability

The compensated altimeter is an attempt to combine the reliability of the mechanical static pressure altimeter with the precision of the electric altimeter. The dependency of the all-electric altimeter upon continuous electrical power has proved a serious blow to its acceptance, despite many design advantages. All proposals for electric altimeters call for the use of a standby mechanical instrument serving in the manner of a standby compass. The military services, however—the omnipresence of the standby compass notwithstanding—have been reluctant to accept an altimeter which requires a backup instrument on already cluttered panels.

The advantages of the electric altimeter include response to remote signals, the inherent precision of the null-balancing circuits and sufficient power to drive the more sophisticated (i.e. driven tape) altitude displays. The Kollsman compensated altimeter reportedly satisfies the range and precision requirements with reliability. However, its display is limited to one that can be powered by barometric pressure. If the military is to obtain driven tape altitude displays which cannot be powered by barometric mechanisms, it must abandon resistance to backup altimeters.

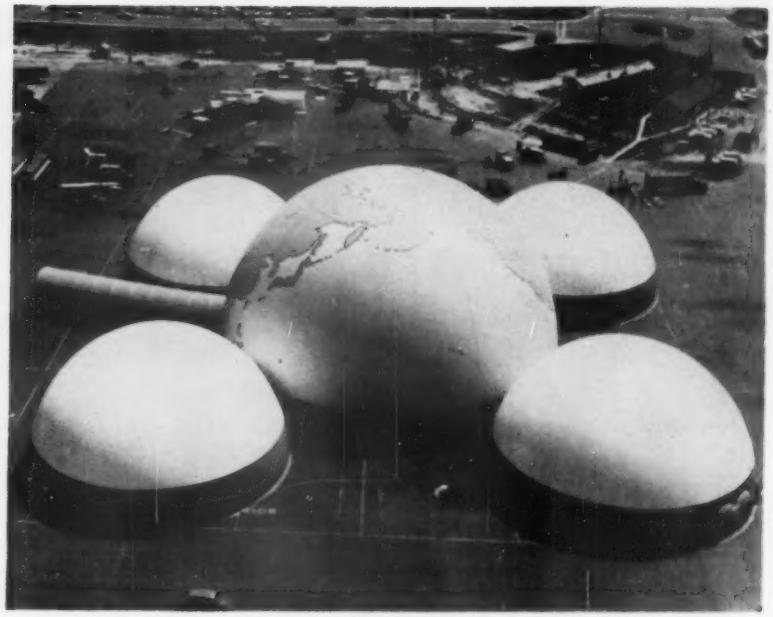
The mechanism of the compensated altimeter is essentially the standard precision MC-3 unit with addition of a Synchrotel rotor and a drag cup motor rotor to the jeweled shafts in the MC-3 altimeter mechanism. The Synchrotel, a company development, is used to introduce altitude variation data in bomb systems and in the Kollsman integrated flight instrument system on jet transports. The synchro, containing neither bearings nor brushes, permits the electrical transducing of altitude data with undiminished accuracy without the use of a servo in the transducer.

The aluminum rotor of a drag cup servo motor, weighing 0.7 grams, is mounted directly on the pointer shaft. On an auxiliary shaft, which meshes with the pointer shaft pinion, is mounted the rotor of the Synchrotel (0.75 grams). The Synchrotel turns once for every 10,000 ft. of altitude. The stator housing of the Synchrotel is rotated by the barometric setting counter drive. Limiting the rotation to 120 deg. obviates the necessity of using slip rings on stator leads. A transistor servo amplifier with a malfunction detection provision is incorporated in the instrument case. The display is a standard counter-pointer presentation with a warning flag to signify standby mode of operation.

Servo Mode

Synchrotel rotation of one turn for 10,000 ft. on the indicator was chosen to provide the widest range of correction consistent with minimizing synchro-synchrotel errors. The indicator pointer's constant mechanical connection to the diaphragm mechanism causes the pointer to be approximately in correct position (within ±5,000 ft.) at all times. Thus, no course (slow) synchro input is required to avoid ambiguity.

The Synchrotel stator, in servoed operation, is energized by the fine synchro transmitter in the external computer or other source of altitude signal. The error signal is amplified to drive the control phase of the drag cup servo motor. This motor, by directly driving the pointer shaft, positions the pointer, counter and the Synchrotel rotor to establish servo null. In establishing servo null, the motor overrides the altimeter mechanism to the transmitted value of altitude. The servo provides



Air-Supported Domes House Maintenance Facility

Dome 150 ft. in dia. at Andrews AFB, Camp Springs, Md., is supported by air under 1/10 psi. pressure which is generated by low-pressure, high-volume blowers. Heavy equipment enters structure through 100-ft.-long pressure lock at left. Smaller domes each 50 ft. high are connected to large dome, forming missile maintenance facility. Domes are made of vinyl-coated nylon; translucent fabric is produced by B. F. Goodrich Chemical Co. Structures are anchored to pavement.

sufficient torque to omit the friction-reducing vibrator usually included to ensure smooth operation.

Barometric correction is introduced by rotating the pressure mechanism in the conventional manner. The Synchrotel stator also is rotated to permit operation independent of the barometric setting. The instrument employs a counter-type barometric setting.

Standby Mode

In the event of power failure, electrical malfunction or if the pilot should manually de-energize the indicator, the correction servo becomes inoperative. The altimeter, thus relieved of motor torque, returns immediately to the normal uncorrected indication. The instrument's operation then is comparable to that of a standard MC-3 altimeter during a power failure (without vibration). Absence of a mechanical clutch or spring return mechanism and Synchrotel and motor brushes ensures unrestrained altimeter operation.

The loss of power on the warning flag solenoid permits the flag to drop into view indicating to the pilot that his altimeter is operating in the standby mode. He may then attempt to reset the altimeter. If reset is unsuccessful, the pilot must take into consideration his possible altimeter error which would be significant only at high airspeed/high altitude flight regimes.

The Synchrotel error signal is continuously monitored by a fail-safe circuit. If the servo error exceeds the equivalent of 700 ft., the relay opens, disrupting primary power and bringing the altimeter mechanism to servo correction. Once the relay has been de-energized, the servo mode cannot be reinstated until the pilot resets.

A resistor in series with the synchro transmitter rotor is connected in a bridge circuit with reference voltage developed in the power supply. If the synchro rotor does not draw normal excitation current through the resistor the bridge will become unbalanced, presenting an error to the fail-safe circuit which then de-energizes the relay, again destroying the primary power.

The compensated altimeter fits a square case conforming to MS 33556 approximately 8 in. long. The weight of the instrument, operating on 25 va. at 115 v., 400 cps., is 4.3 lb.

WHAT'S NEW

Publications Received:

The Story of the U. S. Air Force—by Robert D. Loomis—Random House, 457 Madison Ave., New York 22, N. Y. Landmark Book—$1.95. An account beginning with the Wright brothers and continuing through World Wars I and II, Korea and establishment of the Air Force Academy.

Conquest of the Air—Hendrik de Leeuw—Vantage Press, Inc., 120 West 31st St., New York 1, N. Y. $4.95. A story of man's conquest of the air from legendary times. The approach of the first men in space.

German Secret Weapons of World War II.—Rudolf Lusar—Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. $10.00. A survey of technical data on the secret developments of German weapons in World War II and of Germany's weapon research and development.

USAF Tests Portable Fueling Station

Four North American F-100s are spotted on edge of apron at Myrtle Beach AFB, S. C., during test of portable fueling station. Station consists of five 10,000-gal. Goodyear fabric fuel tanks with interconnecting hose, pumping and fuel delivery equipment, tools, related ground support equipment and personnel for assembly and operation. System can be airlifted in a Douglas C-124 or in two Lockheed C-130s.

WHO'S WHERE

(Continued from page 23)

Changes

Joseph G. Mashman, director of market development, and **Dwayne Kendall Jose,** commercial sales manager, Bell Helicopter Corp., Fort Worth, Tex.

T. Phillips Morgan, director of operations, Consolidated Systems Corp., a Bell & Howell subsidiary, Pasadena, Calif.

Commercial Aircraft Division of Cessna Aircraft Co., Wichita, Kan., announced the following appointments: **Richard N. Robinson,** domestic sales manager; **Roy C. Garrison,** eastern division sales manager; **W. H. Stinson,** western division sales manager; **Eber Bessett,** regional sales manager.

James J. Zimmerman, sales manager, Stratos Division of Fairchild Engine and Airplane Corp., Bay Shore, L. I., N. Y.

Fred M. Gore, industrial design consultant, Mooney Aircraft Co., Kerrville, Tex.

John P. Libbey, manager-international sales, Fenwal, Inc., Ashland, Mass.

Douglas T. Egbert, director of astronautics and research marketing, Northrop's Norair Division, Hawthorne, Calif., and **Wilbur A. Taylor,** director of missile marketing.

Dr. James E. Shepherd has been named scientist manager of the Sperry Rand Research Center, to be built in Sudbury, Mass., this year.

Space Electronics Corp., Glendale, Calif., has appointed the following department managers: **Robert W. Williams,** Subsurface Communications; **W. Robert Hughes,** Terminal Guidance; **Alvin W. Newberry,** Telemetry and Instrumentation; **Ray W. Sanders,** Satellite and Space Systems; **Dr. Rabindra N. Ghose,** Advanced Study and Development. Also: **Marquis Bolton,** program manager for special projects on the Able-Star missile system, and **Robert Stewart,** program manager for special projects on Simicor-simultaneous multiple image correlation.

Donald K. Marsh, general sales manager, Greer Hydraulics, Inc., Los Angeles, Calif.

Kaylock Division of Kaynar Mfg. Co., Inc., Los Angeles, Calif., has appointed the following as assistants to the sales manager: **Henri J. Amigo,** administrative assistant; **Arthur F. Robertson,** service engineer; **Herbert Goldhammer,** sales analyst and marketing-advertising coordinator.

James R. Corcoran, Jr., assistant to the vice president of the Ogden (Utah) Division of The Marquardt Corp.

Edward M. Boyle, director of marketing for the Elkton (Md.) Division of Thiokol Chemical Corp. **Capt. G. T. Atkins** (USN, ret.) succeeds Mr. Boyle as head of the projects department.

E. L. Asch, director of sales training, Vickers, Inc., Detroit, Mich., a division of Sperry Rand Corp.

Kearfott Division of General Precision, Inc., Little Falls, N. J., has made the following appointments in the company's Gyrodynamics operation: **Walter J. Krupick,** general manager; **William Supina,** manager and chief engineer, Precision Gyro Department; **John J. Daly,** manager and chief engineer, Gyro Reference Department.

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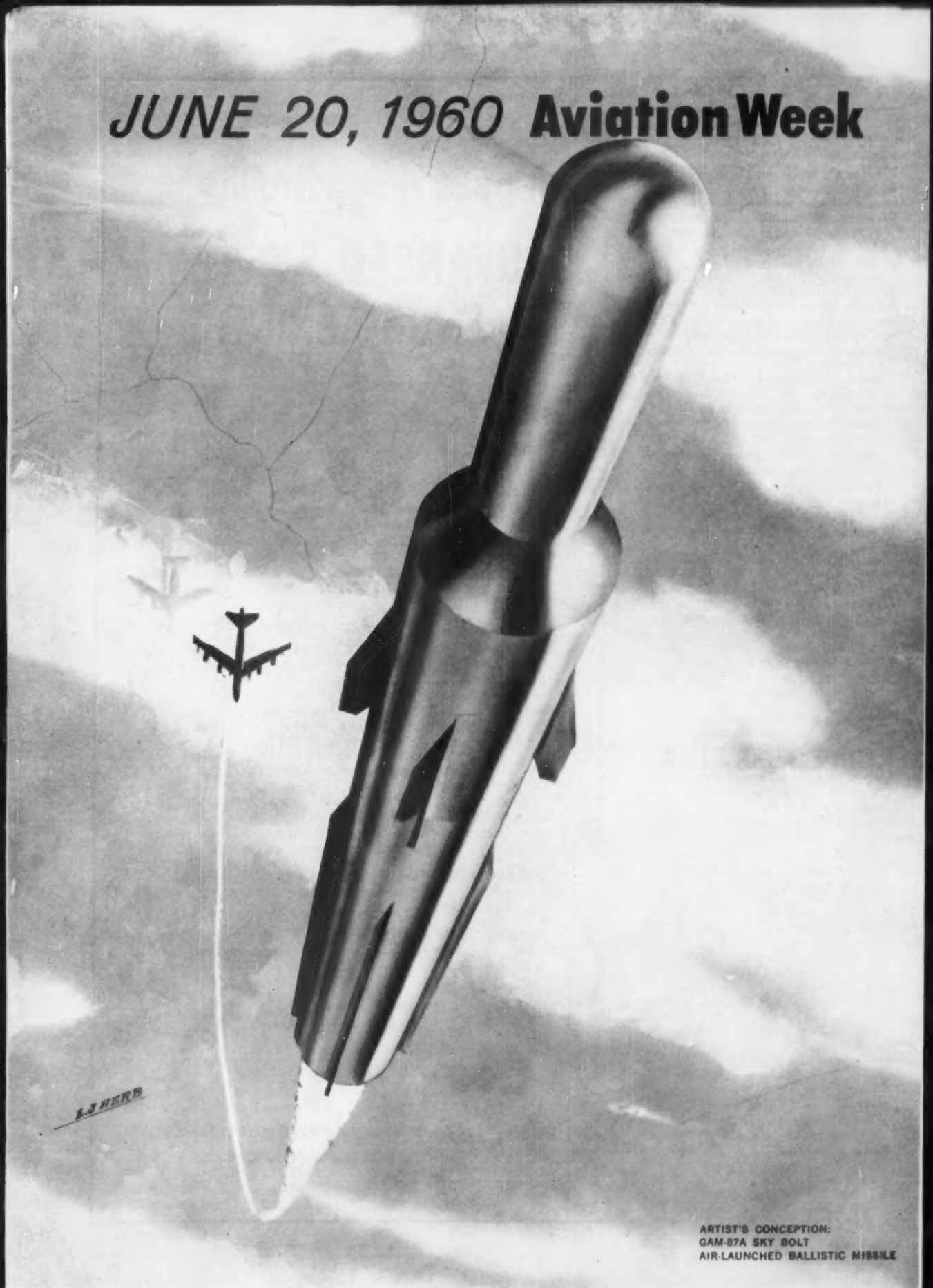

ARTIST'S CONCEPTION:
GAM-87A SKY BOLT
AIR-LAUNCHED BALLISTIC MISSILE

SAC IN TRANSITION

A Special Aviation Week Report on the Strategic Air Command's Transition into the Aerospace Age

The changing role of the Strategic Air Command in the national defense picture will be featured on June 20th in a special 36-page report prepared by AVIATION WEEK editors with on-the-spot coverage of the SAC Command—The nation's shield against aggression.

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AVIATION WEEK editorial teams are now engaged in the compilation of the new SAC story—one that will generate world-wide readership. This issue, "SAC In Transition," offers manufacturers and suppliers of the aerospace industry an unusual opportunity to advertise and identify their role in the national defense effort.

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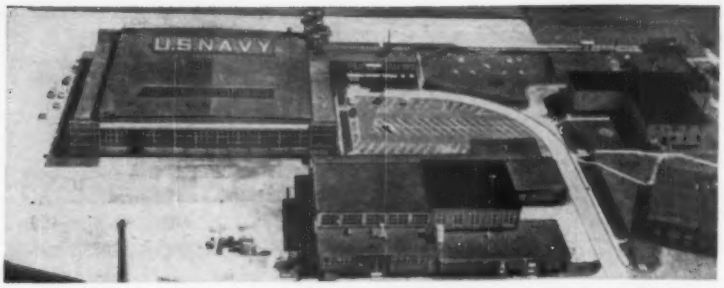

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ADVERTISERS IN THIS ISSUE

AVIATION WEEK, MAY 30, 1960

AMERICAN AIRLINES, INC. 42
AUTONETICS, A DIVISION OF NORTH AMERICAN AVIATION, INC. 16
AVCO CORPORATION, CROSLEY DIV. 74
AVIATION WEEK AND SPACE TECHNOLOGY..56-99

C. B. S. LABORATORIES 6
CAMERON IRON WORKS, INC. 40
CANNON ELECTRIC CO. 24
CHANCE VOUGHT AIRCRAFT, INCORPORATED 78
CONVAIR DIV. GENERAL DYNAMICS CORP.....35-36
CRAIG SYSTEMS, INC. 75

DOUGLAS AIRCRAFT CO., INC. 10

ELASTIC STOP NUT CORP. ..... 4th Cover

GARRETT CORP., THE 93
GENERAL ELECTRIC CO. 7, 86-87
B. F. GOODRICH CO., AVIATION PRODUCTS 82

INTERNATIONAL BUSINESS MACHINES CORP., DATA PROCESSING 88-89

JET PROPULSION LABORATORY 11

KAMAN AIRCRAFT CORP. 4
KELSEY HAYES CO. 17
KIDDE AERO-SPACE DIV., WALTER KIDDE & CO., INC. 22

LAVELLE AIRCRAFT CORP. 5
LEWIS ENGINEERING CO. 82
LITTON INDUSTRIES, ELECTRONIC EQUIPMENT DIV. 103

MINNEAPOLIS HONEYWELL REGULATOR COMPANY 14-15, 20
MINNESOTA MINING & MFG. CO. 8-9, 51
MURRAY CO., INC., A. B. 78

NORDEN DIV., UNITED AIRCRAFT CORP. 13

PACIFIC SEMICONDUCTORS INC. ..... 2nd Cover
PHILCO CORP., GOVERNMENT & INDUSTRIAL DIV. 18
PIPER AIRCRAFT CORP. 54
PRATT & WHITNEY DIV., UNITED AIRCRAFT CORP. 44

RADIO CORP. OF AMERICA 97
RAYBESTOS-MANHATTAN INC. 91
REMINGTON RAND UNIVAC DIV. SPERRY RAND CORP. 12
REPUBLIC STEEL CORPORATION 60-62
RESISTOFLEX CORPORATION ..... 3rd Cover
ROLLS ROYCE AERO. LTD. 48

SCOTT AVIATION CORP. 52-53
SUMMERS GYROSCOPE CO. 79

TASK CORPORATION 72

U. S. A. C. TRANSPORT, INC. 89
U. S. STEEL CORP. 80-81

VICKERS, INC., DIV. SPERRY RAND CORP. 3

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 100-101
EQUIPMENT (Used or Surplus New) For Sale 102

ADVERTISERS INDEX

Bausch & Lomb 100
Charlotte Aircraft Corporation 102
Colorado Oil & Gas Corporation 102
DeKalb County Chamber of Commerce 102
Flying Tiger Line, Inc. 102
Fuzzy Furlong 102
Lenkurt Electric Company, Inc. 100
Minneapolis-Honeywell 101
Radio Research Instrument Co. 102
United States Overseas Airlines, Inc. 102

PROBLEMATICAL RECREATIONS 16

A wizard in Numerical Analysis has a gold chain with 7 links. A Lady Programmer challenges him to use the chain to buy 7 kisses, each kiss to be paid for, *separately*, with one chain link. What is the smallest number of cuts he will have to make in the chain? What is his sequence of payments? *—adapted from the University of California Engineer*

If you like the kind of logic required above, you would probably also like the kind of logic design applied to our large-scale, real-time digital computers. If you are an experienced logic designer, write to Mr. R. W. Robinson.

ANSWER TO LAST WEEK'S PROBLEM: The wind velocity is the diagonal of a square vector diagram, and thus $3\sqrt{2}$ miles per hour.

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Beverly Hills, California

LETTERS

SAC's Duty

Never have I heard such a sad story. As an aircraft commander in SAC just finishing a frequent seven-day alert tour, Brian Power-Waters' "Pilot Problems" letter in your May 9 issue touched my heart. When my telephone rings, I can't pass the buck as Mr. Power-Waters does. When SAC calls, there's a thing called DUTY to be attended to and one comes a-running.

1/Lt. Thomas D. Lambert
Orlando, Fla.

Dusty Strategy

Without finding fault with each particular argument set forth in the "White Paper" (AW Apr. 25, p. 61), two conclusions occur to me.

The first is that the Pentagon, or at least Mr. Gale, is still thinking in World War II terms. The continued comparisons of current nuclear striking forces in terms of the TNT equivalent of World War II capability proves absolutely nothing—except that our strategy is getting a bit dusty.

The second observation is an illustration of the United States' concept of "massive retaliatory forces" as I see it. The phrase calls to mind a caricature of two big, strong men glaring at each other. One (the Soviet Union) is holding a gun (pick your own caliber) on the other (the United States); the United States is saying, "In my pocket I have a stick of dynamite all ready to go. You don't dare shoot me because I have much more firepower in my pocket than you have in your gun. Besides, if you happen to only mortally wound me before I get this 'big stick' out of my pocket to light it and throw it at you and if you don't run away too fast or too far, you too will be destroyed." The improbability that any of these conditions would obtain is obvious.

David A. Stignani
Minneapolis, Minn.

'Sour Grapes'

In the article "Fight Narrows in Air Alert Controversy" (AW May 2, p. 28) Gen. Power is quoted as saying, "you have freed them (Soviet missiles) to attack cities in the U.S." The comment was made regarding the Navy's Polaris program. It would, indeed, be imprudent to continue on a tack which would make domestic areas more vulnerable and more easily accessible to a hostile state. The implications are clear, but the basis for such a comment are somewhat less than crystal. It would appear that some elaboration ought to be forthcoming in order to give the remark an area of tenability, to remove the aura of "sour grapes" which seems to creep through. One can trace the SAC attitude toward Polaris with words provided by none other than SAC—at the outset of the program, "foolish, impossible, never work"—as it progressed, "interesting, surprising, tremendous, must be incorporated in our arsenal"—than when it was clear that the Navy would not readily turn over Polaris to SAC deployment and employment, "too expensive, you have freed them to attack cities in the U.S." The one consistency easily seen in this attitude is ambivalence.

Although it could go without saying, the nature of the Minuteman, with which Polaris would be replaced, is such that it cannot even at less unit cost compete with the great advantage of a Polaris or Polaris-type system. One ought to recognize that the only common ground of Polaris and Minuteman is that they are missiles. Quite obviously Minuteman, dispersed or not, lacks two essential requirements of an ideal missile launching unit—concealment and a high degree of mobility. These two desirable features are readily available in Polaris; also, a submersible launching platform has the added quality of ubiquity.

Seventy per cent of the earth's surface offers a medium through which such a vessel might pass with a low probability of detection. Such a vehicle could launch its weapon, withdraw, and launch another weapon from miles away within a few hours; such activity would continue over an extended period of time until the desired result was achieved.

Putting aside the above controversy, I should like to get to the fundamental question: is the world's wealthiest nation in such straits that its military organizations must seek to progress at the expense of the other services which are, by and large, trying to do their jobs as effectively as possible? Has it been called to the attention of all service personnel that all seek the same fundamental goal, and that as hard as it might be to accept we are on the same side? What about the public who have not yet faced their challenge? What price freedom, is it too expensive?

Please make it known that my comments in no way reflect the Department of the Navy's stand or opinion, but that they reflect only a benighted ensign's despair.

Warren W. Schellhase
Ensign, USNR
Washington, D. C.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Allegheny Crash

In regards to Mr. J. L. De Celles' "Accident Cause" letter (AW Apr. 25, p. 136), I not only violently disagree with his theories but back Mr. Quesada down the line in that improper procedures were used by the Allegheny pilot in the Williamsport, Pa., crash.

My main point of argument is that at no time did Mr. De Celles mention minimum altitudes. Granted, the pilot completed a normal circling approach with all instruments functioning normal (he passed over the field on the first try), but violated the cardinal rule of not executing the authorized missed approach after losing sight of the airfield.

It states on the letdown plate that the airport minimum altitude does not provide clearance over the ridge approximately 1.7 mi. south of the airport. The wreckage was found about 500 ft. below the ridge line. It is "quite possible" that the pilot was attempting to re-establish his position outbound on the west course of the LF range, using the ADF, in order to find the "lost field," which is an unauthorized procedure. Had the pilot been monitoring the aural range signals, he would not have passed south of the range leg. The fact that he remained below authorized minimums is what got him in trouble, hence the improper procedure.

Referring to the theory that the copilot suffered a heart attack immediately prior to the crash, I feel sure that any normal pilot or even one with an "undetectable heart condition" would suffer an attack while riding through this particular approach.

Incidentally, it was one of my helicopters from Olmsted AFB, Pa., piloted by Capt. Thurman Lawrence, that located the wreckage and lowered the first personnel on the scene.

Victor Goudey, Capt., USAF
Commander, Helicopter Unit
Olmsted AFB, Pa.

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Obviously, this would require a huge increase in production facilities. Generous allowances should be made for acceleration costs. The sum of $1 billion is included for this purpose. Each missile is assumed to cost $20 million additional, ready to fire, at a hardened site. In lots of 200, this figure is conservative.

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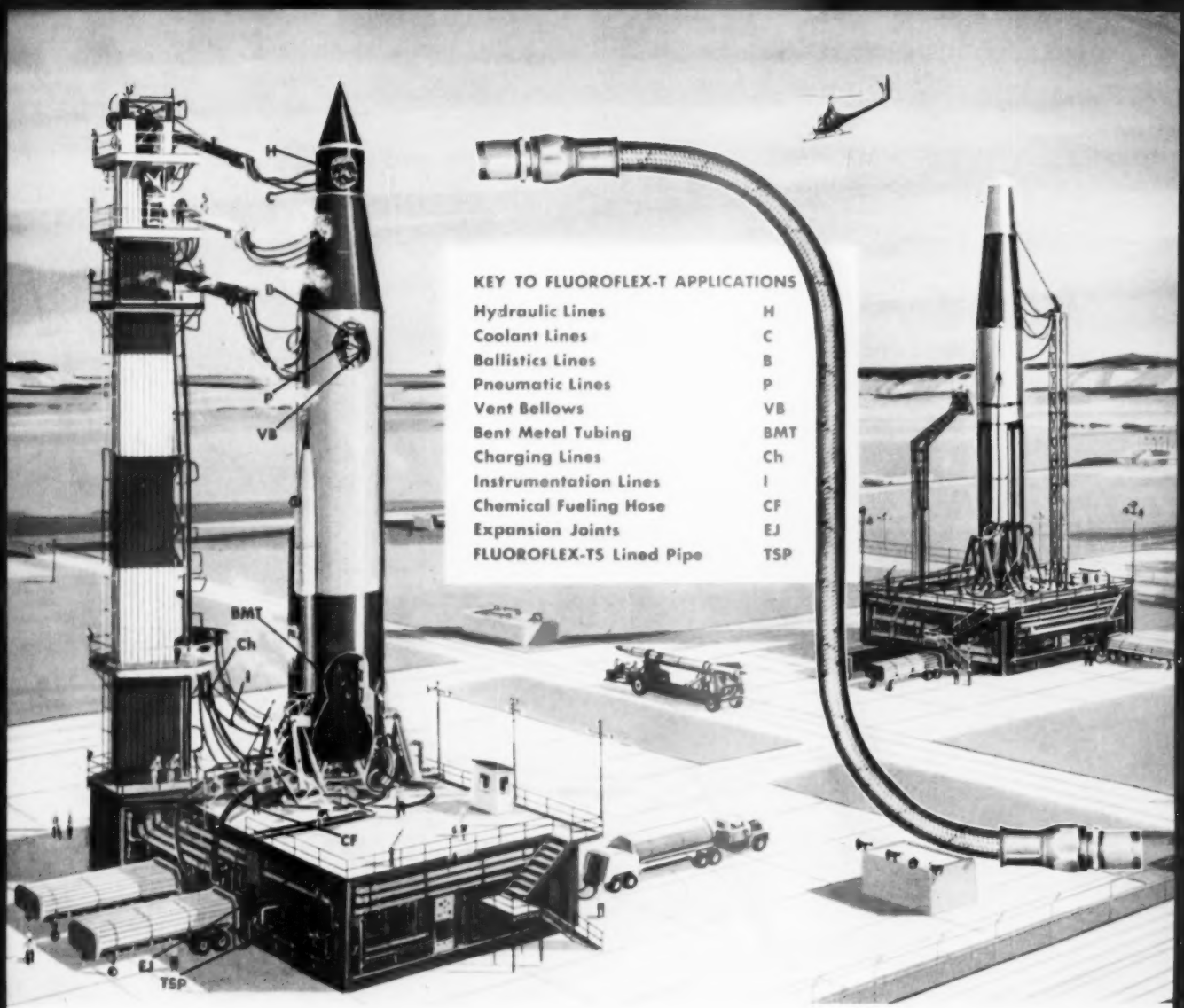
Contrary to the gloomy prophets of fiscal responsibility, there is no inflation, no debt, no financial disaster in this simple proposal. Just a moderate increase in taxes. Consider how little we would have to give up in the way of cigarettes, whisky, malted milkshakes, comic books, chromed tailfins and the like to provide that four cents a day. Are not the real values of the American way of life worth this small sacrifice?

Alan McIlhenny
Berwyn, Pa.



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